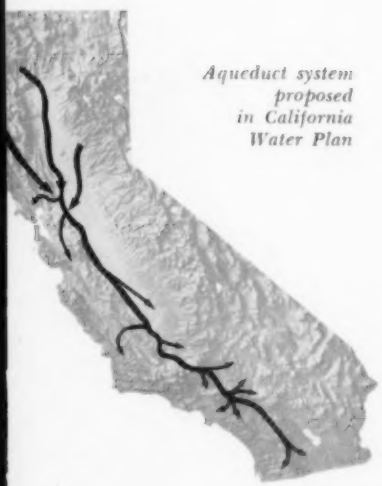
FEBRUARY 1957

Journal

VOL. 49 • NO. 2

AMERICAN WATER WORKS ASSOCIATION



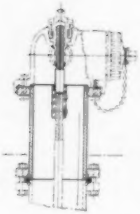
Aqueduct system proposed in California Water Plan

In this issue:

R. D. WOOD, Leader Since 1803, Presents

A Low-Cost Hydrant You Can Depend On

The R. D. Wood Standard Swivel Joint Hydrant gives you the most for your money in strength, reliability and sound design. The *all-bronze stuffing box*, gland and operating nut prevent rust and corrosion. Internal friction which might lower pressure is reduced to well below A.W.W.A. specifications by tapered nozzleways and carefully rounded changes in diameter.



Breakable Flange and Stem Coupling

Available at slight extra cost. Designed to snap under a blow which would otherwise smash the hydrant, flange and stem coupling can be inexpensively and quickly replaced without excavation.

Extension Piece

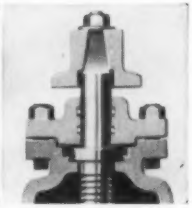
Can be inserted without interrupting water flow.

A Gate Valve Built for Generations of Trouble-Free Operation

The R. D. Wood Gate Valve can be depended on to work and keep on working for years. It is simply constructed — a spreader and two discs are the only moving parts. The discs are free to revolve their full circumference, preventing uneven wear on faces and seats. When valve is fully open, gates are entirely clear of flow.

Hydrants now available with O-Ring Seal when specified.

R. D. Wood Gate Valves now available with O-Ring Seal when specified.



All available with mechanical joint and flange-type pipe connections

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Journal

AMERICAN WATER WORKS ASSOCIATION

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February 1957

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Contents

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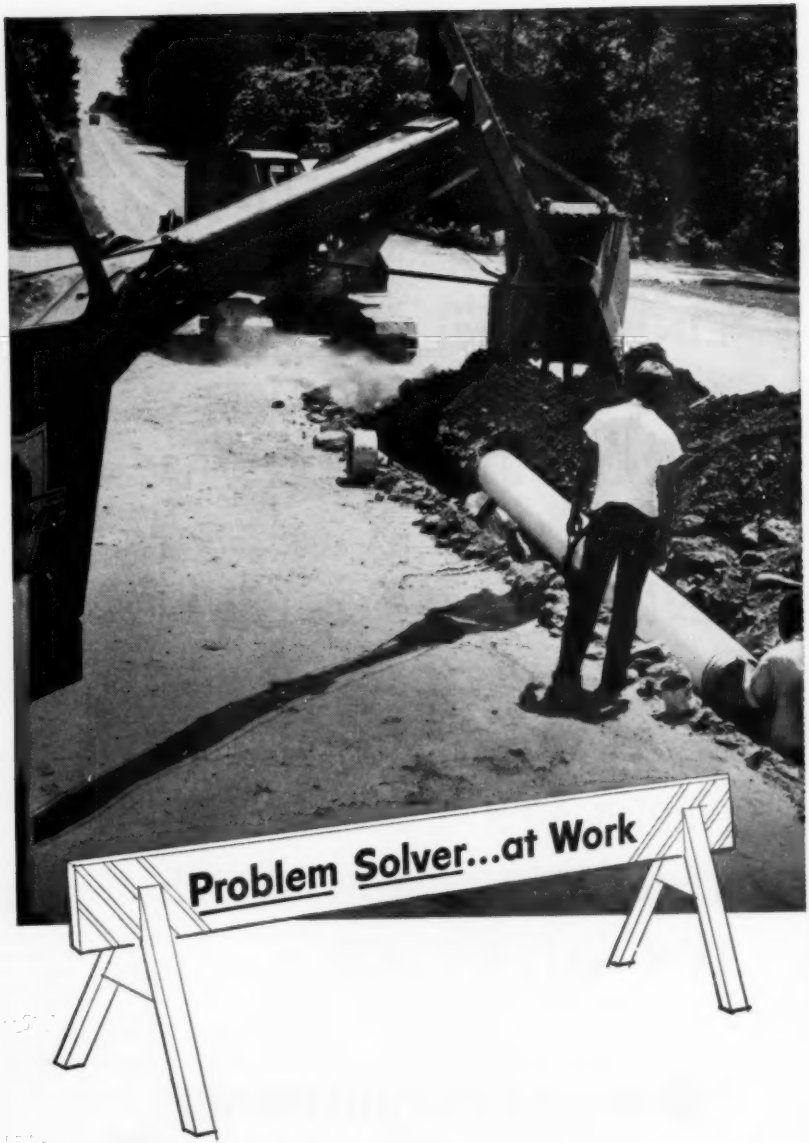
Directory of Professional Services—pp. *55-60 P&R*



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ENGINEERS and city officials face much the same problem in pipe selection. It is twofold: (1) How to make sure the community gets many long years of trouble-free performance from its pressure mains, and (2) How to do this as economically as possible by choosing pipe for durability plus savings.

Transite® Pressure Pipe is solving this problem in hundreds of municipalities and water districts from coast to coast. Here's why. An asbestos-cement product, strong and durable and highly resistant to corrosion, it has effected economies in installation as well as operation.

For example, the community benefits even at the very outset, since both handling and assembly of Transite Pressure Pipe are so simple that crews can install as fast as trench is opened. This means lower installed costs.

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with the RING-TITE Coupling

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AWWA ANNUAL CONFERENCE

Atlantic City, N.J. May 12-17, 1957

Official reservation forms have been mailed to all members and are returnable to AWWA.

Coming Meetings

AWWA SECTIONS

Winter-Spring Meetings

Feb. 14—New Jersey Section Midwinter Luncheon, at Hotel Essex House, Newark. Secretary, Albert F. Pleibel, Dist. Sales Mgr., R. D. Wood Co., 683 Prospect St., Maplewood.

Mar. 17–20—Southeastern Section, at Francis Marion Hotel, Charleston, S.C. Secretary, N. M. deJarnette, Engr., Div. of Water Pollution Control, State Dept. of Public Health, 245 State Office Bldg., Atlanta 3, Ga.

Mar. 20–22—Illinois Section, at LaSalle Hotel, Chicago. Secretary, Dewey W. Johnson, Research Engr., Cast Iron Pipe Research Assn., 122 S. Michigan Ave., Chicago 3.

Apr. 4–6—Arizona Section, at Maricopa Inn, Mesa. Secretary, H. C. Bigglestone, Luhrs Tower, Phoenix.

Apr. 5–6—Montana Section, at Rainbow Hotel, Great Falls. Secretary, Arthur W. Clarkson, Acting Chief, Water Sec., Div. of Environmental Sanitation, State Board of Health, Helena.

Apr. 10–12—Kansas Section, at Broadview Hotel, Wichita. Secretary, Harry W. Badley, Repr., Neptune Meter Co., 119 W. Cloud St., Salina.

Apr. 10–12—New York Section, at Mark Twain Hotel, Elmira. Secretary, Kimball Blanchard, New York Branch Mgr., Rensselaer Valve Co., c/o Ludlow Valve Co., 11 W. 42nd St., New York.

Apr. 24–26—Nebraska Section, at Cornhusker Hotel, Lincoln. Secretary, John E. Olsson, 408 Sharp Bldg., Lincoln.

Apr. 27—California Section, at Miramar Hotel, Santa Monica. Secretary, H. J. Ongerth, 2151 Berkeley Way, Berkeley.

May 2–4—Pacific Northwest Section, at Winthrop Hotel, Tacoma, Wash. Secretary, Fred D. Jones, Asst. Supt., Water Dept., Rm. 306, City Hall, Spokane, Wash.

(Continued on page 10)

Coming Meetings

(Continued from page 8)

Jun. 6—New Jersey Section Spring Outing & Luncheon, at Canoe Brook Country Club. Secretary, Albert F. Pleibel, Dist. Sales Manager, R. D. Wood Co., 683 Prospect St., Maplewood.

Jun. 12–14—Pennsylvania Section, at Bedford Springs Hotel, Bedford Springs. Secretary, L. S. Morgan, Div. Engr., State Dept. of Health, Greensburg.

Jun. 17–19—Canadian Section, at Royal Alexandra Hotel, Winnipeg, Man. Secretary, A. E. Berry, Director, San. Eng. Div., Ontario Dept. of Health, 72 Grenville St., Toronto, Ont.

Fall Meetings

Sep. 4–6—Wisconsin Sec., Milwaukee.

Sep. 11–13—New York Sec., Lake Placid.

Sep. 18–20—Ohio Sec., Cincinnati.

Sep. 23–25—Kentucky-Tennessee Sec., Louisville, Ky.

Sep. 25–27—Michigan Sec., Detroit.

Sep. 25–27—North Central Sec., Fargo, N.D.

Sep. 29–Oct. 1—Missouri Sec., St. Louis.

Oct. 13–16—Southwest Sec., Oklahoma City, Okla.

Oct. 16–18—Iowa Sec., Des Moines.

Oct. 20–23—Alabama-Mississippi Sec., Biloxi, Miss.

Oct. 23–24—West Virginia Sec., Wheeling.

Oct. 24–26—New Jersey Sec., Atlantic City.

Oct. 30–Nov. 1—Chesapeake Sec., Washington, D.C.

Oct. 29–Nov. 1—California Sec., San Jose.

Nov. 6–8—Virginia Sec., Roanoke.

Nov. 11–13—North Carolina Sec., Raleigh.

OTHER ORGANIZATIONS

Feb. 15–16—National Society of Professional Engineers, at Hotel Francis Marion, Charleston, S.C.

Feb. 18–22—American Society of Civil Engineers, Jackson, Miss.

Mar. 11–15—2nd EJC Nuclear Engineering Congress & Atomic Exposition, at Convention Hall, Philadelphia, Pa.

Mar. 19–21—American Meteorological Society, at Univ. of Chicago. Chicago, Ill.

Mar. 25–29—Western Metals Congress & Exhibition, at Ambassador Hotel and Pan-Pacific Auditorium, Los Angeles, Calif. Managing Director, W. H. Eisenman, 7301 Euclid Ave., Cleveland 3, Ohio.

Apr. 2–4—Corrosion Control Short Course, at Extension Study Center, Univ. of Oklahoma, Norman, Okla.

Apr. 8–12—American Welding Society, at Hotel Sheraton, Philadelphia, Pa.

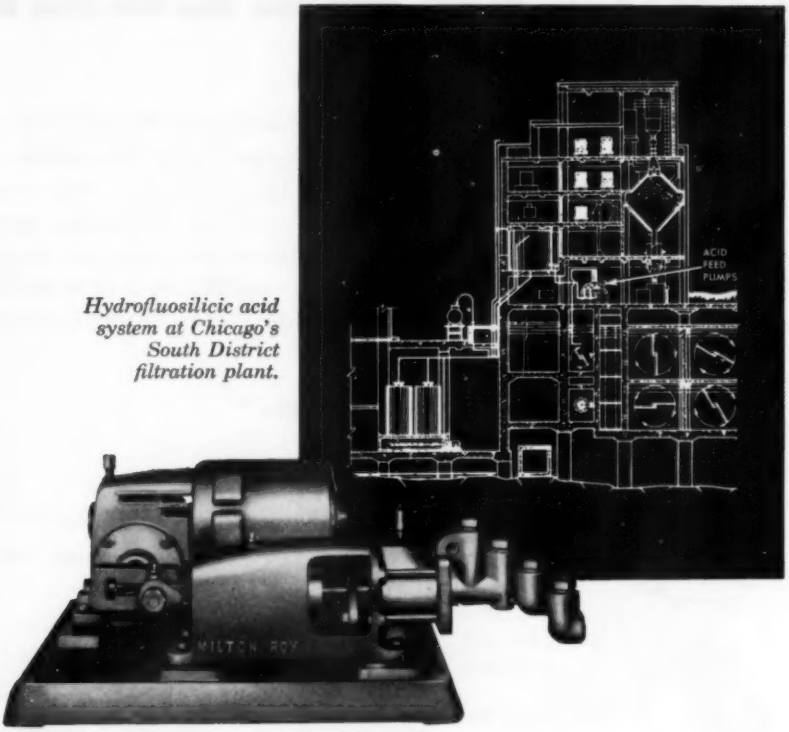
May 13–15—Industrial Waste Conference, Purdue Memorial Union Bldg., Purdue Univ., Lafayette, Ind.

Jun. 2–6—Municipal Finance Officers Assn., at Hotel Lowry, St. Paul, Minn.

Jun. 16–21—American Society for Testing Materials, Atlantic City, N.J.

Oct. 7–10—Federation of Sewage & Industrial Wastes Assns., at Statler Hotel, Boston, Mass.

Nov. 2–8—World Metallurgical Congress, sponsored by American Society for Metals, at Chicago, Ill.



Hydrofluosilicic acid system at Chicago's South District filtration plant.

Controlled Volume Pumps feed fluorides to Chicago's water

Every day, 1400 gallons of 23% hydrofluosilicic acid are added to 340,000,000 gallons of water at Chicago's South District filtration plant. The exacting job of feeding this highly corrosive acid in correct proportions is entrusted to Milton Roy Controlled Volume Pumps.

The Controlled Volume Pump system consists of three direct-displacement pumps, powered by one electric motor through variable speed transmission. One pump serves each of three acid mixing basins. Each pump has a maximum capacity of 43 gallons per hour.

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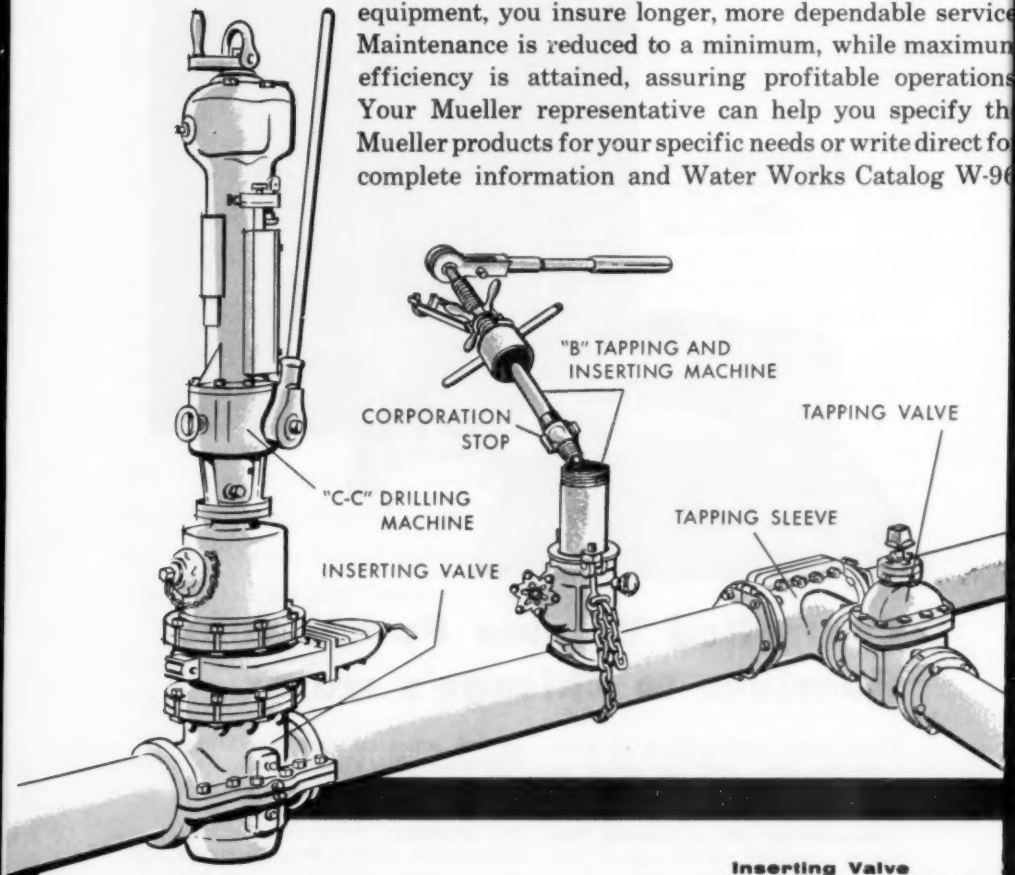

it's Mueller... all along the line...

Inserting Valve
Provides additional control at vital points in existi lines. Installed, under pressure, without interrupti service or losing water. Operates like a regul Mueller Gate Valve, with easy operation and positi shut-off. Parts are interchangeable with Mueller Ga Valves. For 4", 6" or 8" lines.

"C-C" Drilling Machine
Hand operated. Makes 2" to 12" cuts in any size ma dry or under pressure to 500 p.s.i. 25" boring b travel. Automatic feed for drilling; hand feed f rapid advance. Power operated C-1 machine with or gasoline engine power units available. Feed in cator standard on both C-C and C-1 machines.

"B" Tapping and Inserting Machine Drills and taps mains and inse ⅛" through 1" corporation stops in mains under pr sures to 90 p.s.i. May be used on pressures 230 p.s.i. with power clevis. Combined relief and b pass valve permits easy operation of the flop valv

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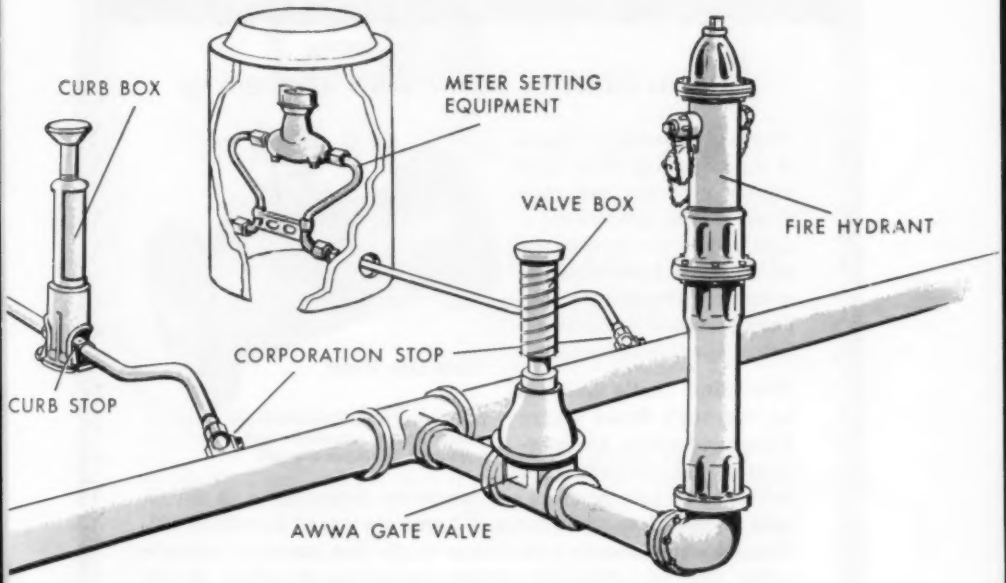

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...apping Sleeve

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...apping Valve

...ersize waterway allows full-size cut and maximum ...w. Exclusive four-point disc wedging mechanism ...oduces tight shut-off and trouble-free operation. With ..."ring stem seal or conventional packing. Sizes 2" ...ough 16". Hub or mechanical joint type ends.

Valve Box

Two or three piece – sliding or screw types for valves 3" and larger. 5¼" shaft. Valve box adapters and extension pieces for both types. Also available, 4¼" shaft, roadway screw type for 3" and smaller valves.

AWWA Gate Valves

Exclusive four-point wedging mechanism distributes seating pressure equally to four points near outer edge of disc. Shut-offs are fast, easy, positive. Permanently lubricated stem thrust collar for reduced maintenance on "O" ring type valves. Stem seals are "O" ring or conventional packing. Rising or non-rising stem.

Curb Stop

Ground key is individually lapped, precision fitted into body of cast water works bronze. Steep key taper gives ease of operation, long life, positive pressure tightness. Cap and tee on inverted key type has accurate built-in check. Sizes ½" through 2". Inverted key or solid head type.

Curb Box

Telescoping section prevents damage to box, stop or service line. Phosphor bronze spring holds upper section in place while back-filling. Lid is bronze-bushed for easy removal of access plug. Rigid support given by arch-type base. Coated with protective tar-base enamel. For stops ½" through 2".

Fire Hydrant

Dry top design with "O" ring stem seals keeps moisture away from operating threads. Lubricating reservoir gives positive lubrication each time hydrant is operated. Safety flange and stem coupling limits traffic damage to small inexpensive parts - hydrant barrel and stem are re-used. Compression-type main valve. Double drain valves force flushed each time hydrant is operated.

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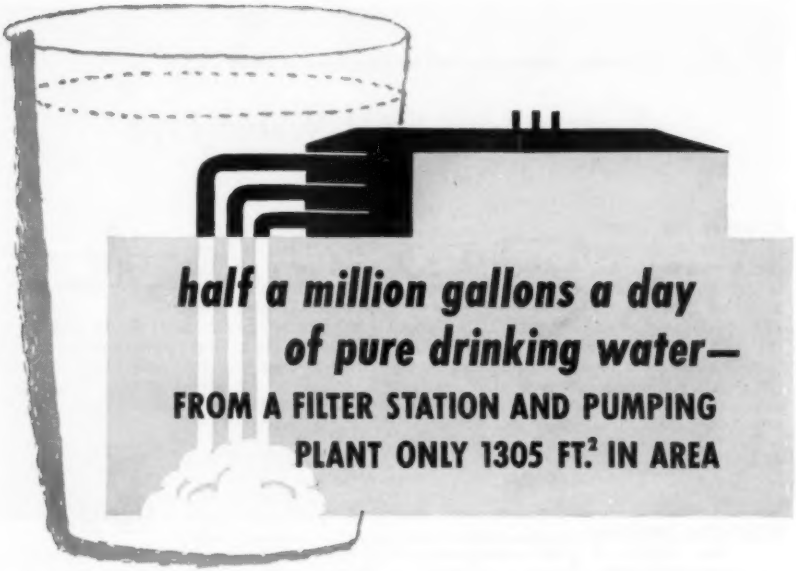
Copper meter yoke with multi-purpose connectors... relocation yokes...iron meter yokes...plain or locking angle stops...meter couplings...each with a variety of inlets and outlets.



half a million gallons a day of pure drinking water—

FROM A FILTER STATION AND PUMPING PLANT ONLY 1305 FT.² IN AREA

That's what Tupper Lake, N.Y., gets from its modern diatomite filter system. And they can get more if they need it, for this filter station can supply as much as 1,750,000 gpd if necessary!

Tupper Lake, a town of about 7,000 people, added this filter system to supply peak demands which could not be met with their regular gravity supply. Tupper Lake itself furnishes the additional supply through a 14-inch intake line. The pumping station and filter plant, 29 x 45 feet, includes a 3-compartment wet well from which water is drawn by 3 turbine pumps of 2,000,000 gpd combined capacity. Four diatomite filters, each with 153 sq. ft. of filter area, can deliver 1,224 gpm at a filtration rate of 2 gpm/sq. ft. filter area. The precoat is maintained during interruptions by a 30 gpm pump on a re-circulation bypass. Operated at the usual rate of 0.57 gpm/sq. ft. filter area (500,000 gpd), the filters have a maximum run of 87 hours.

Total cost of the entire installation, including land, was less than $125,000 – substantially below estimated costs for a conventional system. Under average conditions, 19 lbs. of Dicalite is sufficient to precoat a filter, and 300 to 400 lbs. of Dicalite per million gallons filtered is required as body feed.

For complete information on the many advantages of Dicalite filtration in potable supply, send for our Bulletin F-552

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Pittsburgh-Des Moines water storage with a "college degree" for dependability and economy serves this Eastern Pennsylvania school assignment. Built for the General State Authority, the double-ellipsoidal PDM elevated steel tank has a capacity of 300,000 gallons, a diameter of 44 ft and head-range of 30 ft 9 in. It is supported on a tubular column tower, 114 ft 6 in. to bottom of capacity.

Let us quote on your water storage requirements. Write for our latest Catalog.

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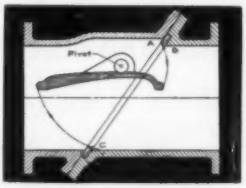
With a Chapman Tilting Disc Check Valve, there's no noise, no vibration, no fluttering. There's no banging or slamming with damage to system or valve. There's no scraping or wearing of disc and seat. Your head loss or flow resistance is kept at a minimum.

To put it briefly, with a Chapman Tilting Disc Check Valve, there's little or no maintenance even under severe operating conditions.

For Chapman Tilting Disc Check Valves in iron and steel . . . valves for handling fluids or gases under a wide range of pressures . . . valves for replacement or new piping systems . . . just check our Catalog 30-A. It's yours for the asking. Send for it now.

Never a Flutter, Never a Slam!

Designed and Built for Quiet Efficient Operation



In open position, specially designed "airfoil" disc balances perfectly. No vibration. No flutter. When flow subsides, disc drops quickly and quietly to a tight closed position. No jarring. No slamming. No damage to system or valve. Note enlarged area around disc to insure low flow resistance.

The CHAPMAN Valve Mfg. Company
INDIAN ORCHARD, MASSACHUSETTS

Journal

AMERICAN WATER WORKS ASSOCIATION

VOL. 49 • FEBRUARY 1957 • NO. 2

The California Water Plan and Its Administration

Panel Discussion

A panel discussion presented on Oct. 25, 1956, at the California Section Meeting, San Diego, Calif., as a full day's survey of that state's water problems and their proposed solution. The complete proceedings of the session are printed here, not only because they give a valuable picture of a rational approach to a serious problem on a statewide basis, but because they demonstrate how an AWWA Section can play an effective part in the development of a practical solution that will be acceptable to the public and all concerned.

California Is Listening—*Samuel B. Morris*

A paper presented by Samuel B. Morris, Cons. Engr., Los Angeles, Calif.

THIS is a momentous year in the progress of the State of California and in the evolution of public water supply. Our state population continues to grow at the phenomenal rate of 1,000 per day. The immigration to California during the past decade represents the greatest voluntary migration in human history. California, with a population of 13½ million is now the second largest state in the Union.

In the past 50 years there has been a greater evolution of public water supply as an enterprise than has occurred heretofore. Our private water systems have grown from small mutual water companies to public utilities operating in many communities. Our small-town water works have grown from small plants, administered directly by mayors and councils, to large municipal water departments operating under citizen utility boards with a high degree of independence and as effective business enterprises. Our largest cities have built great aqueducts hundreds of miles long to bring water

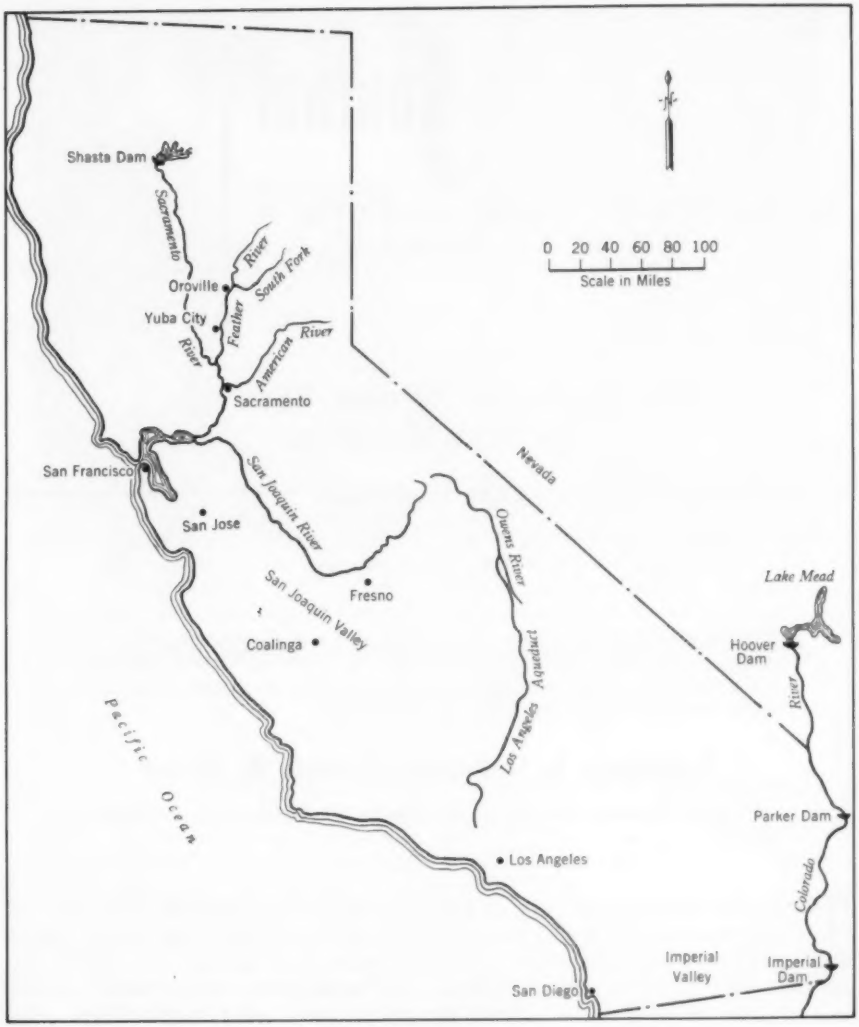


Fig. 1. Location Map

from the Sierra Nevada mountains to the great coastal metropolises of Los Angeles and San Francisco.

Metropolitan Water Districts

The procurement of distant water supplies in later years has involved the combined efforts of metropolitan water districts such as the East Bay Municipal Utility District with its Mokelumne Aqueduct, and the Metropolitan Water District of Southern California with its Colorado River Aqueduct. This latter district provides water to

more than 70 cities from Los Angeles to San Diego and contains, within itself, many districts such as the San Diego County Water Authority, which, in itself, serves several cities.

State Water Problem

Now the problem has grown larger than can be properly met by even so large a metropolitan water district as that of Southern California which contains nearly half the population and assessed valuation of California. The primary reason for this is that the surplus waters of the state exist in the North Coastal Area, north of San Francisco, and in the Sacramento Valley. Large conservation storage facilities and aqueducts, extending as far as 500 miles, are required to bring water from its source in the north to its most southerly destination at San Diego.

Studies of California Resources

Let us look back for a moment to the progressive study and development of California's water resources. The first important studies of the state's water resources were made by William Ham Hall, State Engineer from 1878 to 1889. His studies were of great importance to the already growing state.

After the first World War, spurred on by the aggressive spokesman and former member of the US Geological Survey, Col. R. B. Marshall, the state again undertook important studies and investigations under State Engineers Paul Bailey and Ed Hyatt. Their studies culminated in the formulation of the great irrigation program to bring water from the surplus of the Sacramento Valley to the land surplus and water shortage areas of the San Joaquin Valley.

Central Valley Project

This project, known to all as the Central Valley Project, was approved by the voters of California, including a bond issue for its construction. This was in the depression days of the early 1930's. When the state asked for assistance from the federal government in financing its program, it was decided that the federal government itself would construct the Central Valley Project. It has done so through the Bureau of Reclamation supplemented by storage works built by the Corps of Engineers, both of which have built excellent works.

California Water Plan

After World War II, the legislature directed the State Water Resources Board, through the State Engineer, to make a very thorough study of the state's water resources, reporting on the total water resources, the total need for water for the ultimate development of the state and, finally, plans for developing water to meet the ultimate requirements of California. State Engineer A. D. Edmonston, followed by Harvey O. Banks, has reported that there is sufficient water in California, including California's rights in and to the waters of the Colorado River, to meet all its ultimate future needs, even when the state shall have grown to a population of 40 million and when nearly 20 million acres of lands are being irrigated.

The problem is to provide adequate storage, both surface and underground, to construct long aqueducts and pumping plants, and to bring

water from areas of origin to areas of need. Multi-purpose water projects are necessary to provide for domestic and industrial water supply, irrigation, hydroelectric power, flood control, fish and wildlife, recreation, pollution control, and all other purposes having to do with the utilization of California's water supply.

The first unit of the California Water Plan for bringing water from areas of origin to areas of need, is the Feather River Project, adopted by the state legislature in 1951.

Department of Water Resources

Faced with the tremendous task of building such works as the Feather River Project, estimated to cost from one and a half to one and three-quarters billion dollars, and the ultimate California Water Plan, several times this amount, the governor and the state legislature decided upon an important change in organization of the state government. Supervision and direction of water supply was raised from the status of a division within the Department of Public Works to the Department of Water Resources under a director and an assistant director reporting directly to the governor of the state. A part-time citizen board has been named by the governor to advise with the director of the Department of Water Resources.

I am certain that the citizens of California, especially the members of the AWWA have added confidence in that the governor has named able fellow members of this Association to the top positions: Harvey Banks, former State Engineer, to be Director, and Marcel J. Shelton, formerly General Manager and Chief Engineer of the La Mesa, Lemon Grove and Spring Valley Irrigation District, as Deputy Director of the Department of Water Resources.

Water Rights Board

At the same time, the control over water rights has been lifted from a place in the old Division of Water Resources in the Department of Public Works to an independent agency under three full-time commissioners, constituting the State Water Rights Board.

—Water Problem for the Legislature—*Harold J. Powers*—

An address presented by the Honorable Harold J. Powers, Lt. Governor, State of California, Sacramento.

The subject for this meeting, "The California Water Plan" points up the necessity of a statewide concept of water development, if our state is to continue its phenomenal growth and development.

Although the plan is without precedent in its scope and detail, statewide water planning is not a new thing in California. Today's plan has been preceded by a number of investigations, some of which approach it in scope and magnitude.

Earliest of these was published by the House of Representatives as early as 1874. It was entitled "The Irrigation of the San Joaquin, Tulare, and Sacramento valleys in the state of California." It outlined a hypothetical plan for irrigation of these great val-

leys which today give California its top ranking status among agricultural states.

Other investigations by state and federal agencies followed during the next several decades, the most noteworthy of which was one by William Ham Hall, State Engineer from 1878 to 1889. His reports contained detailed information on weather conditions, streamflows, with notes on irrigation, drainage and flood control. All of this data proved extremely valuable in later studies of California's water problem.

The most comprehensive investigations of recent years were compiled by the State Engineer under authorization of legislative acts of 1921, 1925, and 1929. Results of these studies, plus subsequent additions and revisions were published in 1930 (*1*) and were presented to the legislature in 1931.

This far reaching plan was approved and adopted by the legislature, and was designated the "State Water Plan." This plan with only minor variations is a reality today in the Central Valley Project, built by the federal government.

Subsequent investigations resulted in bulletins outlining in greater detail a coordinated development of the water resources of the Central Valley, development of the water resources of the Santa Ana Basin, and of the Colorado River Basin in California.

Legislation

Development of the water resources of California long has been recognized as primarily the responsibility of the state. Expressions of state policy regarding water supply development are found in the state constitution and in numerous court decisions. The state water code incorporates three very pertinent sections:

Sec. 100:

It is hereby declared that because of the conditions prevailing in this state, the general welfare requires that the water resources of the state be put to beneficial use to the fullest extent of which they are capable, and that the waste or unreasonable use or unreasonable method of use of water be prevented, and that the conservation of such water is to be exercised with a view to the reasonable and beneficial use thereof in the interest of the people and for the public welfare. . . .

Sec. 104:

It is hereby declared that the people of the state have a paramount interest in the use of all water of the state, and that the state shall determine what water of the state, surface and underground, can be converted to public use or controlled for public protection.

Sec. 105:

It is hereby declared that the protection of the public interest in the development of the water resources of the state is of vital concern to the people of the state and that the state shall determine in what way the water of the state, both surface and underground, should be developed for the greatest public benefit.

It was implementation of these policy sections which brought us to completion of this great statewide water plan we are here discussing, and which must be made a reality if full utilization of the state's water resources is to be made.

The legislature in 1945 established the State Water Resources Board, and in 1947 directed the board to conduct an investigation of the water resources of the state. Funds were first provided in the 1947–1948 budget, and

some $8,000,000 have been spent in compilation of this encyclopedic report.

Mechanically, the investigations involved three stages:

1. A complete inventory was made of the usable water resources of the state. All available data on water sources, quantities, and quality were evaluated and the results published in a bulletin. From this inventory it has been shown that there is available in California slightly more than 70 million acre-feet of surface water annually.

2. An analysis was made of the present and ultimate water requirements of the state. The present use of water for all consumptive requirements, based in general on the capabilities of the land to support further development, was determined. Also discussed were nonconsumptive uses of water for fish, wildlife, recreation and other activities.

3. From this inventory it was established that the ultimate water requirements of California would be about 50,000,000 acre-ft annually. This requirement can be met, but only with a high degree of conservation effort. The California Water Plan formulates methods for satisfying these water requirements, insofar as practicable.

Let me remind you that development of this master plan, or guide for California's water future, was evolved only after costly delays occasioned by the war. And the war itself resulted in a tremendous westward migration of people and industry, thus compounding the delay.

Today California's population is estimated to be 13,600,000 people. More are crossing our borders every day. More and more industries and commercial ventures are locating in California every week. Thus the urgency of the situation is multiplied, and will continue to be multiplied with the passage of time. There can be no interruption or delay again, or we will be inviting tragedy.

The planning engineers have virtually completed their work. They have investigated, come up with the facts, and proposed solutions to the problems posed by those facts. The studies and plans of the engineers are only volumes of paper on the shelf until a decision is reached which will implement those plans with projects.

This decision is not one for the engineers. They plan, present facts, and make recommendations. The next step is up to the people of California, acting through their elected representatives, to decide when and whether these plans will be converted into projects which will use the water resources for the greatest benefit to the greatest number.

What then has been done in this direction? What are the prospects for the immediate future?

Hearings

The first step in this direction was completed in early October, 1956 in Sacramento, when the last of a series of nine public hearings on the California Water Plan was held. These hearings, held in every section of the state, served a dual purpose. The recommendations and suggestions received assisted the Department of Water Resources in adding the finishing touches to the plan for presentation to the legislature in January 1957. In addition, they served to focus public attention on the problem. That, in itself, is a necessity, for without solidified public opinion, there can be no decision and no real action.

Interest in the hearings was remarkable. More than 1,500 persons attended and some 200 statements were presented.

Was the California Water Plan prepared without consideration of alternate plans developed by groups and individuals? Absolutely not. Hearings also have been held by a Board of Consulting Engineers to review other plans, among them the Reber Plan and the Weber Plan.

Before the present plan can be translated into legislative action, and from there into concrete and steel instruments for water storage, flood control, power, irrigation water, and water for domestic use, other preliminaries are called for. In our orderly legislative processes, it is right and necessary that these preliminaries be carried out to inform, to judge, and to weigh all facets of the problem.

For example, hearings have been conducted on the so-called counties-of-origin problem by a joint subcommittee under the chairmanship of Assemblyman Patrick McGee. This problem is brought into focus by the proper concern in areas of origin of water that their ultimate needs be met, or guaranteed, before surplus water is exported. The mountain and foothill communities must be given adequate assurance that their needs will be met, and the areas of deficient water supply must be assured of their proper share of water developed by state projects. These assurances can be given because there is enough water for the needs of all if we control and conserve it. The McGee Committee is concerned with finding methods for giving these assurances.

There has been some question as to what agency would construct and operate the San Luis Project, a vital link in the state's Feather River Project. To obtain all of the facts on this important problem, hearings were conducted at Coalinga by the Assembly Committee on Conservation, Planning and Public Works, under the chairmanship of Assemblyman Francis Lindsey.

Probably no better site for the hearings could have been chosen. Not only is Coalinga in the heart of the project service area, but its water problem is so acute that water for drinking purposes is hauled into the community in tank cars, and at the fantastic cost of more than $2,000 per acre-foot.

Further hearings have been scheduled. In October 1956, the Joint Committee on Water Problems, under the chairmanship of State Senator Howard Williams, looked into the problem of drainage in the San Joaquin Valley. Locale for these hearings was Los Banos, near which the first large-scale irrigation developments in the state were begun shortly after the close of the Civil War.

Senator Williams' committee scheduled a meeting for Dec. 3, 1956, to consider the total water problem and legislative action required in 1957. Similar considerations stimulated discussions on Oct. 31 and Nov. 1, 1956, at public meetings set by the State Water Board and the Department of Water Resources. At those meetings, results of previous hearings and presentations of conclusions to the legislature were considered.

Do all of these hearings and meetings constitute delays in California's water development? Far from it; in fact, they should be considered milestones toward that goal, for they are a part and parcel of the great legisla-

tive processes which make our system of government the finest in the world.

Action Required Now

That is the background. The entire problem has been thoroughly researched for many years, even many decades. Getting the facts has cost about $8,000,000. It has been debated and discussed from every point of view.

The studies have shown without a doubt that California does have enough water, providing that we retain our just entitlement to the Colorado River supply. They have shown that water for all is a matter of our own action in conserving and distributing, and that in doing so we can not only cure our problem of water shortage, but we can put an end to devastating floods.

In reviewing the discussions, the debate, the endless days of fact finding, there is an extremely encouraging note. There has been remarkably little basic disagreement. All points of view are actually quite close to a central area of agreement, and there is general agreement on all of the broad, essential points. But even with this encouragement, we must recognize that failure to act in time can mean complete defeat of our main objectives.

Let me repeat, for the emphasis it deserves: The engineers have studied, we all have discussed and debated; now is the time for specific action.

There are several reasons for urgency; but the major one, and the one least understood by the layman is this: After we decide to act, many years are required before we actually realize a drop of water in the tap, or a potential flood threat forever bottled up.

Let me cite a few examples of what this could mean in terms of years.

Previous Projects

Men of vision in Los Angeles in 1900 first foresaw the possibility of bringing Owens River water to the metropolitan area. Engineers investigated, and men debated and discussed, much as we are doing today. Several campaigns and two bond issues later, the project was begun.

The first Owens River water reached Los Angeles in 1913, or 13 years after the plan was a gleam in the eye of what were then called "visionary" planners. By 1924, Los Angeles saw that this supply would be insufficient, and wheels of progress went into motion toward what eventually would be the Boulder Canyon Project and the Colorado River Aqueduct. Then followed the same process which resulted in an entirely new concept of a federally financed, multipurpose water development.

Repayment was guaranteed by the people of Southern California through public agencies and private utilities which signed contracts to buy electric power produced by the project. The great Metropolitan Water District was formed in the meantime, and voted $220,000,000 for the Colorado River Aqueduct. But it was 1941, or 17 years after first steps were taken, that water was delivered to the metropolitan area.

San Francisco experienced even greater delays in translating thought to action in solution of its water supply problem. Shortly after 1900, investigations were begun, looking toward a firm water supply from the Tuolumne River, and it was not until 1934, or more than 30 years later, that first water deliveries were made.

Large as these projects were, they are small compared to those needed today.

Section Cooperation

There are people in California even today in this period of fantastic growth who cannot think in big terms. To them the projects we see before us in the immediate future are dismissed as impossible. And the concept of California constructing the Feather River Project is termed ridiculous.

You in the California Section of the AWWA have tackled and solved big water problems. You are used to thinking in big terms. You can be of great service to your state if you will help others think in these same bold terms.

As you well know, understanding these big concepts on the part of the public is absolutely essential in order that their decisions be wise ones—decisions which will not be regretted 50 years from now. Your people depend on you for leadership in their thinking on water problems.

In a field famous for its amateur "experts," you—the 1,349 members of the California Section—represent 1,349 professionals. As such, it is your responsibility to acquaint the public with the facts which have been made available by these years of study and to counsel and support the legislature as these matters are considered.

Seventy-five years or more ago, self-reliant California farmers solved their own water problems as they saw them in that era. Dozens of irrigation and other local water districts have wrestled with their problems of short supply, financing, water rights, and many other obstacles and have come up with the right answer. Los Angeles, San Francisco, San Diego, Oakland, and other communities have obtained water supplies through energy, initiative and foresight.

California can well emulate these local groups in solving their larger problems. We must face up to meeting our own problem and solving it ourselves. We should seek all of the federal aid possible, within the framework of state law and within the scope of the California Water Plan.

But in no event should California permit waiting for such aid to delay the solution of its own problems. The California Water Plan envisions large participation by the federal government in the construction of some, and aid in the financing of other, water projects. The plan does not anticipate that the federal government can be the sole construction agency for California's water projects.

If all of the projects which we in California see as being essential in the next two decades were to be financed by the federal government, they would require more than the total federal budget for such projects in the entire nation.

To think that we can call on the federal government to spend all of its water development funds in California alone in order that we can avoid facing up to financing our own needs would be unrealistic and wishful thinking.

Self-financing not only is an investment in the future, but one with a high cash return. It has repeatedly been demonstrated that money spent on a water system which permits expansion of a city, a county, or a state is a gilt-edged investment.

An adequate water supply pays direct dividends. Not only does an adequate water supply result in agricultural, business, and industrial expansion for the general well being of the people of the state, but it repays directly to the state treasury in the form of an increased tax base, higher in-

comes, greater retail sales, and, of course, cash from water use.

In helping to bring about understanding on the part of the public, I hope you will keep in mind that your aim is understanding and not added confusion. This calls for statesmanship, not merely political consideration of the most attractive approach to the problem. Statesmanship can lead to agreement which will permit us to get on with the job.

Let's not be guilty of making loud noises to attract attention to ourselves and to appeal to those who are more intrigued by excitement than they are interested in progress.

That brings us to the crux of the problem—legislation. And if you feel that I have been overly long in reaching this point, I must observe, on the basis of many years of legislative experience, that on such a highly important and absolutely vital issue as this, one just doesn't say "let's pass legislation", and presto, the job is done and the dirt begins to fly at the dam sites.

Time for Legislative Action

Legislation such as we need now must be based on the overall picture, on the needs and wants of all the people of the state. It must be based on facts, and on the willingness of a majority of the people to accept not only the facts but the proposed solution. This takes time, and it takes the kind of process which I have been discussing. That is why I have devoted so much time to a discussion of the preliminaries so essential to success in this legislative undertaking.

But now is the time for action. We must act to give legislative sanction to the California Water Plan as the master plan or guide for California's water future. Meanwhile, while we move toward the solution of many problems such as water rights, counties of origin, details of aqueduct routes, where to build dams and reservoirs, and how to finance, we can move on to the early phases of construction of the Feather River Project.

We need water and we need flood control—not in that distant some day after we talk endlessly, but now. We already are late. Neither the areas of deficiency nor the areas of periodic and devastating floods can wait.

Ask the good people of Yuba City. Oroville Dam could have spared them the appalling loss of life and crushing economic loss of the 1955 Christmas week.

Ask the people in southern areas of water deficiency, where water is now being rationed and, business faces economic strangulation for lack of a future water supply to meet its expansion.

Let us move forward on Feather River Project appropriations so that the great project can become a reality serving the people of California, and not merely an engineering dream intriguing the imagination of a few dedicated persons.

We can and must rise to statesmanlike decisions as citizens capable of making a wise determination of our future.

Water—not too little and too late—but enough and on time—can insure a future for California beyond our most fantastic dreams.

Reference

1. Bul. No. 25. Div. of Water Resources, Sacramento, Calif. (1930).

The Program of the Department of Water Resources—

—*Harvey O. Banks*

A paper presented by Harvey O. Banks, Director, California Dept. of Water Resources, Sacramento, Calif.

In California those portions of the state which, during the winter and spring season, have more than adequate amounts of precipitation are among those experiencing water supply problems later in the year. In that situation we have illustrated the one overall problem with which all of us are contending—the extremely unbalanced distribution of our very sizable water resources. When one examines the runoff characteristics of the US, one sees that in California we have some of the most arid land in the nation, with precipitation of 1 in. or less per season, and we have areas with an average over 100 in. of precipitation per year. In some of these latter locations last winter there was more than 125 in. of rainfall, yet by summer the same areas were short of drinking water.

As every part of California has a present or potential water supply problem and as—providing, of course, we retain our proper share of Colorado River water—we do have within our borders the water resources with which to provide the answer to our problems, the plans for accomplishing this goal must be truly statewide in concept, and are of very real concern to all those interested in water supply matters throughout the entire state.

It is self-evident that we have reached and passed the point where we can, with any reasonable degree of discretion, continue without such a master plan for water development covering all of California. Such planning has been accepted as proper, and necessary in most fields, including highways, communities, transportation, schools, and others. In the utilization of what is perhaps the most vital of our natural resources, it is the more important that we operate along recognized sound lines of procedure.

The California Water Plan is the logical third step outlined in a series of bulletins. The first (*1*) gave an inventory of available data on sources, quantities, and characteristics of water in California. The second (*2*) presented a study of present water use throughout the state, and of anticipated future needs. The third (*3*) presents the physical means of controlling, conserving, and distributing the adequate supply of water available to meet the needs as reported in the second.

Having determined that there is sufficient water to meet the ultimate needs of all parts of the state for all purposes and having evolved and accepted as a general guide a plan whereby the water can be made available when and where needed, we have facilitated subsequent steps in the necessary legislative program.

Need for Legislative Program

We need to take all necessary legal steps to reserve the water required for the full development of all areas of origin throughout the state. At the present time, the only protection afforded the counties of origin is through the state filings made in furtherance of general and coordinated plans of

water development. These filings were formerly made by the Director of Finance, but now are the responsibility of the Department of Water Resources. The procedures for handling these filings must be made more workable.

The so-called Counties of Origin Law merely prohibits the assignment of these state filings in such a manner and to such an extent as to deprive the state's upper areas required to meet their ultimate needs. Thus, protection is afforded only in limited areas where state filings have been made. Actually, the areas of origin cannot be limited to any particular region of the state, as each watershed within the state contains an area of origin and is entitled to protection. The department staff is working on a plan for presentation to the legislature to give maximum protection to all areas of origin. This is one of the important and difficult, but by no means insurmountable, problems which will come before the legislature.

We must devise means for the permanent and firm allocation of the water made available by state projects among the beneficiaries of those projects in the areas of deficiency. Such a method will need to be implemented by legislation, and quite possibly confirmed by constitutional amendment. We must utilize the economic strength of the entire state in controlling and putting to use the water resources of the state. This must be done in such a way that the areas of deficiency will have permanent assurance of the water to meet their needs, without infringing in any way on the rights of the areas of origin to have the water both now and in the future.

I believe that a solution can be found to these problems, because the essential element of compromise is here. There is an impelling necessity for all interests to find a basis for working together on development of the state's water resources. No one can afford unnecessary delay.

Areas needing water can only obtain it from the north. Considering the years necessary for construction of facilities to conserve and transport the water, there is no time to be lost if the high level of economy is to be maintained and expanded.

In the areas of origin, the people do not necessarily have the use of their water. Much of it is now being "exported," without limit and without control, and without first serving the needs of the areas in which it originates.

Accomplishing the control requires large amounts of money. The economic strength of all of California is needed to finance the type of developments required for the future of the mountain and foothill areas. The continued prosperity of the metropolitan centers of the state is vital to the well-being of these communities, just as the continued growth and development of the mountain communities is essential to the welfare of the entire state, and to one of its major attractions, the tourist business.

Failure of intelligent men of good will to work together in solving this problem would be so patently unwise and self-defeating that I am convinced that the people of California will act in a positive manner on the counties of origin problem.

When we have reached the solution to this question of water allocation, we as a state must establish a policy for operations in the field of water development. I remind you that the California Water Plan as it will be presented to the 1957 legislature, is

not a construction proposal, nor does it concern itself with the economic justification or financial feasibility of the various projects listed in it as physical means of developing the state's water supplies. Under authorization of the legislature, we are embarked on this next phase of planning under the California Water Development Program. As a part of that program there must be a determination of the state's policy as to what projects it should construct, to what extent it should participate in the construction of others. In line with that policy, there must be a construction program and plan, a determination of the order in which we will proceed.

Having devised a plan and program for state participation in water development, it will be necessary to determine a plan of financing. This is a key point in our studies, but one which is susceptible of definition only in its proper sequence. One aspect of this problem concerns financing for large projects of extended areal benefits such as the Feather River Project.

The areas of origin are concerned less with the legal reservation of water for future use than they are with the matter of whether, when, and how the projects will be financed and built to control and develop the upper area water resources to serve the needs of those areas. This is a matter of money, rather than of law, but the answers may well affect legislative agreement on the counties of origin question. Thus financing plans must consider the needs for projects of localized benefit.

State construction of projects is only the beginning of the question of finance policy. The California Water Plan contemplates eventual construction of 260 major reservoirs to conserve and distribute water throughout the state. Many of these could and should be constructed by local agencies, but within the structure of the California Water Plan. This, in some instances, may require construction of works in a manner and size beyond particular needs or the capability of the local agency, in order to achieve the full benefit envisioned by the California Water Plan. To bring about construction of such projects, it may become necessary for the state to participate financially in locally built and locally operated project to the extent of the state interest.

In order to facilitate construction of projects as they become necessary in every part of California, it may be advantageous for the state to establish a water development loan fund, to assist local agencies in meeting the needs of their service areas, with projects locally constructed and operated.

We anticipate that a considerable part of the cost of water development can be borne out of current revenues. A general obligation bond issue to supplement available current revenues will no doubt be necessary. Our studies on these matters are not finalized, but are being pursued with the aim of readying specific proposals for presentation to the legislature in 1957.

Federal Participation

Closely related to the matter of financing is the relationship of federal and state government in water development.

The President Advisory Committee on Water Resources Policy said in its report:

> The greatest single weakness in the federal government's activities in the field of water resources development is the lack of cooperation and coordination

of the federal agencies with each other and with the states and local interests. There has been inadequate coordination of the program of one agency with that of another and inadequate consultation with and consideration of the interests of the states, local communities, and individuals most vitally affected.

That same report says:

> It is not practicable, and certainly not desirable, for the federal government alone to assume responsibility for the complete development of the nation's water resources. This reasoning stems not only from the practical impossibility of assuming the financial burdens which such a policy would require, but also from the fact that such complete federal assumption of responsibility would tend to create local and regional dependence upon federal action, to destroy individual and local initiative, to destroy the effectiveness of the government of the states, and to work a profound and undesirable change in our traditional plan of government.

This describes rather well the position of California as to the state-federal relationship in water development. The federal government has spent, over the past twenty years, large sums in water development work in California, but has not been able to keep pace with our ever increasing water needs. We do not see any possibility that the federal government can provide funds in sufficient amounts to construct all of the works we need; nor do we believe that all of our needed developments are sufficiently within the scope of federal interest to justify construction by the federal government. We are also much concerned with safeguarding our water rights; we do not want to see complete nationalization of our water resources. We need and welcome the financial assistance and cooperation of the federal government in solving our problems—provided that it is done within the framework of our state water laws and in accordance with our master plans.

California's water resources can best be developed by close cooperation among all agencies—federal, state, local, and private. For maximum cooperation, however, careful definition by the Congress of the role of federal agencies is needed. There are a number of phases of the federal–state relationship which need congressional action, but the most urgent problem is that created by the 1955 Pelton Dam decision of the US Supreme Court. In that case, the court held that where the licensing jurisdiction of the Federal Power Commission was based solely on the fact that the proposed hydroelectric plant would occupy federally reserved lands, the licensee could build and operate the plant even though it had not complied with the laws of the state relating to the use of water. The decision appears to have nullified to a great extent the traditional concept, long recognized by Congress and the states, that state law shall govern the acquisition and administration of rights to the use of water. This threat to the integrity of state water law and to vested rights has been greatly aggravated by administrative interpretations of the decision which have been made by the Department of the Navy, the Department of Justice, and the Federal Power Commission.

The Barrett Bill was introduced at the last session of Congress in 1956 as an attempt to solve the situation created by this decision and to cure many other points of difficulty between the states and the federal government. It did not come to a floor vote. A

somewhat narrower approach to the problem is contained in a resolution adopted at the convention of the Association of Western State Engineers, held at The Dalles, Ore., in September 1956, based on a draft of proposed legislation prepared by attorneys of the California Department of Water Resources. This action proposes that the Congress resolve that:

> . . . it is hereby determined and declared to be in the public interest that title to, and the control of the acquisition and exercise of rights to the use of, all navigable and non-navigable waters, surface and underground, within the boundaries of the respective states lying wholly or partly west of the ninety-eighth meridian shall be, and they are hereby confirmed, established and vested in each of such respective states. . . .

Integration of Projects

Insofar as specific projects in California wherein cooperation of the state and federal government is required, the most familiar is the San Luis Project in West San Joaquin Valley. In this, as in other matters, cooperation between the state and the local regional office of the Bureau of Reclamation has been excellent. Active steps are being taken by the Department of Water Resources and the Bureau of Reclamation regional office in Sacramento to resolve the physical and engineering problems of modification of the San Luis Unit to function as a part of the state's Feather River Project. The Commissioner of Reclamation, in his report on the San Luis Unit submitted to the Secretary of Interior on Jun. 18, 1956, said that he is in full accord with the state's objectives of integrating the San Luis Unit with the Feather River Project, and that he is confident that satisfactory means can be found to accomplish this.

In order that Central and Southern California obtain water deliveries from the Feather River Project, use of the San Luis Reservoir site is essential.

I must emphasize our position which holds that, in the public interest integration is practical and necessary in the public interest. This means integration starting, with the design phase, so that water can be delivered to the Feather River Project service areas in Kings and Kern Counties at the same time that Fresno County, in the San Luis Unit, is provided with water. We also believe that the basic principles governing integration must be written into legislation authorizing the project, and that the contractual arrangements between the federal and state governments must be consummated before construction starts. This procedure is in accord with recently indicated policies of the federal government to the effect that repayment contracts must be executed prior to starting construction on federal projects.

These areas of federal–state relationships are among the vital legislative decisions ahead of us in 1957.

After I have enumerated all of these problems which will go before the state legislature and the Congress in 1957, you may consider me inconsistent when I say that the first action we will request of the legislature is an urgency appropriation for beginning of construction on the Feather River Project before any of these other questions can be resolved.

There are those who say that we should delay further action on the first major project to be constructed and operated by the state of California until all of the problems I have listed today are decided. This would delay dangerously the start of physical construction which will, at best, require

many years to complete. Realistically, final answers to many of our most perplexing questions must be derived from the construction and operation of our first state project. Had we waited until we had thoroughly debated and convinced everyone of the merits of flying before the first airplane was built, we still would be earthbound. Often physical performance is simpler than explanation and theoretical unanimous agreement. We need to convert talk and plans to reality, remembering that nothing succeeds like success.

Today there is little disagreement as to the need for the Feather River Project. There is disagreement in method of legislating the distribution of benefits, and the details of aqueduct routes. There is no question that Oroville Dam is needed, and is almost financially feasible solely on its merits as a flood control and hydroelectric power project. Assuming that we receive a $75,000,000 contribution from the federal government for flood control purposes, the balance of the cost of Oroville Dam, a reservoir, a power plant and appurtenant structures, can, except for $35,000,000, be repaid out of power revenues over the 10-year period of development plus 40 years of operation under bond issue financing. Thus, proceeding with the project could at most cost the state $35,000,000 if no water were ever sold. This is indeed a small "risk" to take while we work out the legal, engineering, and financial details connected with operation of the whole Feather River Project and the California Aqueduct System.

Appropriations Requested

As far as the Department of Water Resources is concerned, engineering work on the Oroville Dam and reservoir site will be sufficiently advanced to have permitted a request for an urgent appropriation in January 1957, to start actual relocation of the Western Pacific Railroad and the Feather River highway which will be inundated by the Oroville Reservoir. We also will request appropriations in the 1957–1958 budget for continuation of that work and for the relocation of other utilities which must be moved, as well as for continuing the engineering and detailed explorations necessary for an early start of the dam construction. These actions are of the greatest importance; water supply and flood control benefits of the project are needed as soon as possible.

Reports submitted to the 1957 legislature will include: engineering reports on the feasibility of upper Feather River Projects; a report on an aqueduct to San Diego County which can presently be used to deliver surplus Colorado River water on an interim basis, but which could be used for conveying water from Northern California when such water becomes available in Southern California; and, possibly, recommendations for the construction of projects in the upper Feather River.

Conclusion

In conclusion, the program on which legislative decision is required in 1957 should consider:

1. Legal sanction of the California Water Plan as the master plan for California's future water development
2. Extension of legal water protection to all areas of origin throughout the state, and making the procedure for handling state filings more workable
3. A means for permanent and firm allocation of water made available by state projects among the beneficiaries of those projects

4. A policy for the state in the field of water development, and in line with the policy, a construction plan

5. A plan for financing state projects and for state participation in local projects in which there is a statewide interest

6. Legislative and congressional action to clarify federal–state relationships in water development

7. Urgent appropriations to expedite actual construction of the Feather River Project.

The California Water Plan hearings and public reaction throughout the state have produced a clearcut indication of a specific insistence on the part of the people of California that there be action now on development of the water resources which are theirs and the use of which they need or will need within less time than that which is required to construct the needed works. As leaders in this area of public concern, we may find it difficult to explain or justify any failure to heed this directive. As we move toward a program of aggressive action to meet the needs of our state, we will require your counsel and leadership. We require this not *if* but *in order that* we may succeed in these efforts on which the future of California so largely depends.

References

1. Bul. No. 1, Div. of Water Resources, Sacramento, Calif.
2. Bul. No. 2, Div. of Water Resources, Sacramento, Calif.
3. Bul. No. 3, Dept. of Water Resources, Sacramento, Calif.

—Program of the Water Rights Board—*Henry Holsinger*—

A paper presented by Henry Holsinger, Chairman, State Water Rights Board, Sacramento, Calif.

Chapter 52 of the First Extra Session of the 1956 California State Legislature provided for reorganization of the former Division of Water Resources of the Department of Public Works. The act abolished, as of Jul. 5, 1956, the division and the office of its chief, the state engineer, and transferred most of his functions to a newly created Department of Water Resources. Those functions not so transferred were vested in a newly created State Water Rights Board which was thereby charged with the duty of administering the following laws:

1. The appropriation of unappropriated water through the permit and license procedure

2. Assistance to the courts and parties in adjudication of water rights

3. Administration of an act enacted by the 1955 legislature concerning recording of data relating primarily to use of ground water. This act is restricted in operation to five Southern California counties.

The new State Water Rights Board is an independent agency separate from the Department of Water Resources. The State Water Rights Board has no connection with the State Water Board. The latter is the former State Water Resources Board, renamed and continuing to exist primarily as an advisory body to the Director of Water Resources. The close similarity in the titles of these two boards is unfortunate as it has created confusion. Similarity of the two boards does not extend much beyond their names as their functions differ widely.

The State Water Rights Board is made up of three members appointed by the governor subject to confirma-

tion by the state senate. The members serve for staggered terms, and represent the state at large. They are removable from office for dereliction of duty, corruption, or incompetency by concurrent resolution of the legislature adopted by majority vote of all members elected to each house.

One member is required to be an engineer, another an attorney, and the third is undesignated. The Governor appoints one of the members as chairman to serve at his pleasure. The first members serve for varying terms, and thereafter, all serve 4-year terms. Those currently appointed are W. P. Rowe, John B. Evans, and the writer. All meetings and hearings of the board are open to the public.

Board Functions

The two functions of the board relating to the appropriation of water and participation in the adjudication of water rights may in general be stated to have now "swung full circle." The former Water Commission Act, now codified in Water Code Divisions 1 and 2, enacted, among others, these major functions now vested in the board. The Water Commission Act, effective Dec. 19, 1914, created the State Water Commission—a five-member board, of whom two were the governor and the state engineer, acting ex officio, and three were appointed by the governor for 4-year terms. In 1919 the act was amended to provide that one of the appointive members should act as executive member to administer the act, subject to a right of appeal addressed to the full commission which having heard the appeal, could affirm, reverse, or modify the action of the executive member. The procedure provided by this amendment enabled prompt action on routine applications, with hearing on appeal "de novo" ("anew") before the full membership of the commission on important issues, if desired. During the effective period of the procedure (2 years), the record is not clear but there were either not many appeals taken or none at all. In 1921 the State Water Commission was abolished and its duties were transferred to the Division of Water Rights of the Department of Public Works. In 1929 the functions were vested in the Division of Water Resources and its chief, the state engineer. This status created in 1929 continued until Jul. 5, 1956.

Present Status of Functions

The immediate future work of the State Water Rights Board is anticipated to be in major part concentrated upon the first of the three functions already mentioned (administration of the law concerning appropriation of water). The board has inherited a heavy accumulation of pending applications to appropriate unappropriated water. The reduction of this backlog to a reasonable proportion will occupy the board and its staff for an extensive period of time. The board is most desirous to do this as promptly as possible and to demonstrate that it proposes to perform its functions fairly, efficiently, and with a minimum of delay. The public, however, in justice to the new board, should recognize that in accomplishing that objective it is confronted with a severe problem which will take time to resolve. A substantial number of these applications are for major projects involving stream systems where numerous other applications are also pending. In such a situation, it is frequently the case that the various applications have a common background of facts, or are even interrelated to such an extent that equitable considerations, as well

as economy of board functions, requires that many or all should be consolidated for hearing before the board. This procedure serves to eliminate duplication of evidence, and reduces the time occupied in hearings, hence minimizing expenses and time of all parties concerned. This process, however, also requires a substantial period of preparation as well as lengthy hearings producing an extensive transcript requiring laborious review prior to decision. Many applications are awaiting results of engineering and economic investigations by public or private agencies, conclusion of court proceedings, or negotiations among concerned private parties or state and federal agencies.

The solution to the problem of backlog of applications, however, is not as simple as might appear. The following example will illustrate this: Several years ago it became established that, in advance of hearing of an application or combined hearing of a number of applications, a staff report is formulated and copies are served on all parties who have appeared. This report contains, among other matters, a list of exhibits comprising official documents containing official notice and notice is given that these documents will contain information relevant to the hearing and be offered in evidence at the hearing. The inference thus is that these exhibits will be introduced as evidence at the hearings.

By this means the parties are apprised of a field of information which the board considers proper to notice at the hearing and, if any party considers notice of any of such items is improper, he will have an opportunity at the hearing to register the objection. If no objection is advanced, then the parties will be cognizant that there will be no need for them to introduce evidence to establish such facts, and the hearing will thereby be shortened and a substantial saving will be made in time and expense. It is believed the practice has had a salutary effect, and has facilitated arriving at just results with a minimum of time and expenditure.

Because of the limited staff available to the board, however, it has not been possible to complete these office reports as rapidly as the board is able to hear the applications. For example, as far as the board itself is concerned, it would be possible within the course of the current fiscal year to hold major water right hearings concerning a number of the larger streams in the Great Central Valley as well as numerous coastal streams in Southern California. Each application requires substantial preparation. Applications which are relatively independent of others and should be heard in separate hearings and those involving smaller quantities of water require more time of the staff for preparation for hearing. This naturally follows as the applications involving the more important projects are usually better represented by engineers and attorneys who can be relied upon to adduce adequately the relevant facts.

Illustrative of the extent and complexities involved in some hearings are the American River hearings which began in late November 1956. The hearings featured 22 applicants holding 66 applications and 73 individuals or entities filing protests against one or more applications. The total number of protests which must be considered by the board is 2,040.

The second activity of the board consists in affording assistance to the courts and the parties in adjudication of water rights. Two independent procedures are available for this purpose;

the objectives of both—to minimize expense and delay of adjudication of water rights—are the same. One only of these procedures is presently available for adjudication of percolating ground water rights independently of surface water sources. These procedures make available to the courts and parties the services of highly trained specialists in their field, as unbiased experts with the accumulated experience of the past 40 years. The activity involves primarily the determination of ancient rights such as riparian rights, overlying rights, and rights by appropriation which have not been acquired pursuant to the application, permit, and license system under the board's jurisdiction. Although a total of some 47 such adjudications have been conducted pursuant to these procedures at the effective date of attachment of the board's jurisdiction, this function was at a low ebb. Work was then being completed on four adjudications, while two were in process. The extent of the activity is not subject to control of the board except to a limited degree. The staff presently occupied with this activity is small, but in the event water shortages were to become acute, the need of substantial expansion might arise with little or no advance notice.

The third board activity is the administration of an act of the 1955 legislature concerning recording of data relating to water extractions and diversions and use of ground water in Riverside, San Bernardino, Los Angeles, Ventura and Santa Barbara counties. The board is in process of making effective rules to govern operation of this act. Administration of the act for the remainder of the calendar year 1956, required only the time and attention necessary for a final preparation and distribution of material to affected parties preliminary to the required filing of notices of 1956 operation. Such notices must be filed before Mar. 1, 1957, and must be in as much detail as can readily be supplied.

It is contemplated that the work load of processing notices of extraction and diversion begun on Jan. 1, 1957, will require a substantial increase in personnel. In addition to the actual recordation of water extractions and diversions with the board, the act provides that the board shall, upon request and upon payment of costs, investigate the facts stated in any specified notice and make its own determination as to such facts. When such a determination is made in any subsequent adjudication, it shall be prima facie evidence of the facts stated therein. The extent of the personnel which will be required for this work is dependent upon the number of requests for verification which the board may receive. It is possible that the work load involved in the recordation activity might ultimately be a very substantial percentage of the total board work load.

The objectives of the recordation act are undoubtedly salutary and decidedly in the public interest. They are to accumulate information which will give protection of the water rights of the users, and, in event of a comprehensive adjudication of common sources of supply, will minimize the expense and delay of such adjudication.

State Water Policies

The board has for its guidance in the administration of the laws for which it is responsible certain broad policy provisions enacted by the legislature and approved by the electorate. These include provisions:

1. That the water resources of the state shall be put to beneficial use to the fullest extent of which they are capable, and the waste of or unreason-

able use or unreasonable method of use of water should be prevented, and that the conservation of such water is to be exercised with a view to the reasonable and beneficial use thereof in the interest of the people and for the public welfare

2. That all water within the state is the property of the people of the state, but the right to the use of water may be acquired by appropriation in the manner provided by law

3. That the people of the state have a paramount interest in the use of all the water of the state and that the state shall determine what water of the state, surface and underground, can be converted to public use or controlled for public protection

4. That the protection of the public interest in the development of the water resources of the state is of vital concern to the people of the state and that the state shall determine in what way its water, both surface and underground, should be developed for the greatest public benefit

5. That the use of water for domestic purposes is the highest use of water and that the next highest use is for irrigation

6. That the right of a municipality to acquire and hold rights to the use of water should be protected to the fullest extent necessary for existing and future uses.

To these earlier policy declarations the legislature in its 1956 reorganization bill has added that "in determining public interest, the State Water Rights Board shall give consideration to any general or coordinated plan prepared and published by the Department of Water Resources, or any predecessor thereof, looking toward the development, utilization, or conservation of the water resources of the State."

The Board's Program

The board is making progress toward its objective of expediting and making current all pending applications to appropriate water. However, its program must necessarily be geared to its progress in staff organization. Possibly the most difficult task of all is the recruitment of personnel to complete the staff necessary to implement an accelerated program. Preparation of a budget showing expenditures for the current year in excess of funds received from the defunct Division of Water Resources is completed to the stage of filing a request with the Department of Finance. Application is also being made to the Department of Finance for allotment from the emergency fund of the additional funds required. Work is also in progress on the board's budget for the 1957–1958 fiscal year. Arrangements have been made for new quarters in Sacramento, but the difficult task of moving is still ahead, as is also completion of organizing and staffing of the Los Angeles office.

From the foregoing it is apparent that before the State Water Rights Board and its staff can become fully operative, numerous difficulties must be overcome which concern the initial organization and functioning of the board as a new governmental agency. Problems involved in this process must naturally be given first priority, but without awaiting final solution the board proposes to attack the major problem which consists in reduction of the backlog of pending applications. The rapidity with which the accumulation over past years can be reduced, and eventually eliminated, depends on the availability of funds and qualified personnel. These problems, as has been indicated, are not as yet resolved and quite probably cannot be until, by

legislative action, adequate funds are made available for the requisite expanded program.

The board brings up for hearing the protested applications which are or can be made ready for action as rapidly as possible. On Sep. 25, 1956, a hearing was commenced on applications of the United States to appropriate 1,600,000 acre ft of water of Putah Creek annually at Monticello Dam for use in Solano County. Direct testimony was concluded and Oct. 22 was set for introduction of further evidence and cross examination of expert witnesses. On conclusion of the hearing, a decision was to be prepared and final action taken on the applications.

Other hearings involving relatively small amounts of water followed. The November hearings of the American River applications which included those of the United States for the 1,000,000-acre ft Folsom Reservoir, and the $85,000,000 power project of the Sacramento Municipal Utility District. It is anticipated that American River hearings may require several weeks of actual hearing time, with continuances of varying length prolonging the time of completion to probably some date in 1957. Setting of other hearings, major and minor, will follow.

These hearings bring into focus the importance of the function of the board which deals with the administration of the statutory law concerning acquisition of rights to the use of the unappropriated, that is, the unused water of the state. There are many ramifications of this subject, some of which may profitably here receive brief consideration. The California Water Code, Sec. 102, declares that "All water within the state is the property of the people of the state, but the right to the use of water may be acquired by appropriation in the manner provided by law." In this brief section, a distinction is inherent between the ownership by the people of all water as a natural resource and the derivation from the people through duly constituted official bodies and officers, of rights to the use of that natural resource. For the implementation and protection of those rights, the water code provides a complete system governing acquisition of rights by appropriation, and Sec. 1225 of the water code provides that this system must be followed in order to acquire such rights, with exception of rights to the use of percolating ground water not part of a surface stream. The procedure may be briefly summarized as involving three major steps: [1] filing application; [2] issuance of permit, followed by construction of works and application of the water to beneficial use in accordance with the permit; and [3] confirmation by issuance of license of the right acquired by use. All permits are issued expressly subject to vested rights including, among others, riparian rights, overlying rights, and prior rights by appropriation.

There are pending before the board a large number of applications, some of which were filed by individuals and private entities, such as partnerships and corporations while others have been filed by or on behalf of public agencies at different levels of government, ranging from local districts, cities, and counties to state and federal agencies and instrumentalities. Applications filed by all these public and private agencies are of identical nature and are subject, generally, to the same rules: Applicable procedures must be followed with diligence commensurate with the magnitude of the undertaking, and failure to continue to use the water for a consecutive period of 3 years forfeits the right. To these rules there are certain exceptions not here necessary to detail.

Appropriation of the unused water of the state is a subject in which the public as a whole has, or should have, an active interest. The public also has a vital interest in current plans for the full development, conservation, and use of all the state's water resources. Such plans are currently under formulation by the Department of Water Resources. However, the State Water Rights Board has its part in putting those plans into effect, for it is on agency of the state to which is delegated the function to pass on all applications made for purposes of those plans. The board also has power to grant, deny, or impose conditions so that plans conform to the public interest. What the public interest requires is, generally, a question of fact to be found by the board with conclusions therefrom to be drawn by it. All decisions made by the board, of course, are subject to judicial review.

The board considers that the situation here briefly portrayed constitutes a challenge and it has accepted that challenge.

In conclusion, I assure you it is the earnest desire of the State Water Rights Board, by its future activities, to establish an enviable reputation for fair, prompt, efficient, and impartial performance of its functions, and having established such a reputation, to continue to maintain it.

Where Should Local Water Authorities Take the Initiative?—*John W. McFarland*

A paper presented by John W. McFarland, Gen. Mgr., East Bay Municipal Utility District, Oakland, Calif.

We have had for some time in our country two strongly contrasting views with respect to federal and local control. With the formation of the present national administration, there was evidenced, in the field of water policy, of a great swing from the emphasis on federal control to an emphasis on local capital and initiative. This does not mean that there has been a general acceptance of this change in emphasis, and I am sure that for many years to come there will be a swinging back and forth between these two points of view.

With the formulation of the California Water Plan and the possibility of state financing, we are looking forward to the possibility of much greater state activity. A third contrasting view will, therefore, be introduced now, as state financing and control assumes its rightful place and proportion. This is bound to raise many problems for both private and governmental local agencies as they will now have one more large governmental unit with which to deal. It is true that a state agency will perhaps have more of a "family" aspect. Nevertheless, from the particular standpoint of the small local agency, any large higher level of governmental agency always has the frightening aspects of a bureaucratic operation. I suppose, too, that with greater state activity, local plans will be increasingly difficult to work out because of their possible conflict with other centralized long-range plans. In the minds of many local government officials there will lurk the apprehension that the state may usurp some functions that are properly local, and there will be many editorials burning up the pages on this subject.

In this regard it is, of course, very heartening to hear the assurances of cooperation by the State Department

of Water Resources. These assurances have been emphasized repeatedly at recent hearings on Bul. No. 3 wherein spokesmen for the Department of Water Resources and the State Water Board have repeatedly emphasized the important role that the local agency must play. We would be less than realistic if we did not anticipate that as conflicts arise, the same may not still hold with future state administrations.

It is probably in the field of planning that the local agency must take its first and strongest step. Local agencies are closer to their own problems, they are better able to determine what the future problems will be, and they are more especially alert to unusual or unique problems of supply that may affect them. Also, it is of course only through adequate local planning that appropriate support can be developed for any overall state plan. Obviously, local planning has its limitations in varying degrees depending largely upon size. Smaller local units need the helping hand of others, and joint planning should be encouraged. I think that larger governmental units should encourage both local planning and joint local planning because, in the absence of such local planning, there can be no ultimate local responsibility. The absence of any feeling of local responsibility will eventually be reflected in the votes of the state legislature.

Local Authorities and Financing

It is when we get into the field of financing and construction and, to a lesser degree operation and management that the major problem is faced by the local agency. I think that in California, as well as in other states, the citizens would prefer to finance and control their own developments. This has been the very keystone of the American ideal, which is in a sense the pioneering spirit, based upon rugged standards of independence. Few will disagree that a local agency which is willing and able to proceed with its water development ought to be allowed to do so whenever the plan is not in conflict with the general or coordinated plan of the state.

It is only when the individual cannot do for himself but must be done for that the governmental function begins to take its rightful place. It was Abraham Lincoln, I believe, who stated this principle when he said: "It is the legitimate function of government to do for the people whatever they cannot do or cannot do as well for themselves." The financing of water developments may very well fall into this category in a number of cases. Sometimes local agencies are not in a position to finance the facilities necessary to develop their supplies. At other times, local agencies may be very well able to finance the facilities required for a short period of time, but unable to finance the facilities required for a long enough period in the future to make them truly worth while. In still other instances, local agencies might be able to finance the facilities necessary for an ultimate future supply, and yet such facilities might not meet coordinated ultimate requirements of adjacent areas. The results in this last instance would be that construction to meet the supply of a local agency would be rendered a complete economic waste when ultimate construction is required to develop that water supply to its fullest use in order to serve a larger area.

It is when we reach these complications that we inevitably will look to higher governmental authorities for assistance, regardless of political or

philosophical considerations, whether they be federal or state.

The Coalinga Case

Let us take a specific case study as an example of a local problem and the complications it presents. It recently came to my attention that the city of Coalinga, Calif., has a very unique problem. I have exchanged some correspondence with Coalinga officials, and the following letter from one of them, outlines the problem very well:

"The City of Coalinga is the main residential and trading center of that area sometimes known as Southwest Fresno County. It is commonly designated more specifically as the Coalinga Union High School District and it is an area of some 900 square miles. . . . In 1954 the value of crop production and of livestock raised in the area was $26,484,245. The value of oil and gas production in the area for 1954 was $86,753,024, and important new oil and gas discoveries will greatly increase this figure. . . .

"School enrollment for 1954–1955 was 2,926 students. The value of the local school plants is estimated at $8,000,000. In addition, a new junior college plant is being constructed at a cost in excess of $850,000, and a new elementary school at a cost of $650,000. The assessed valuation of the area comprising the Coalinga Union High School District exceeds $165,000,000, or more than one-fourth the assessed valuation of all of Fresno County. The population of the city of Coalinga was set at 6,021 by a special federal census taken in 1955.

"The city owns and operates its own water wells and distribution system; however its drinking water must be purchased and hauled from wells located some 45 miles away by railway tank cars at an average rate of 40 tank cars per month. This drinking water, or 'soft water' as it is called, is used for drinking and cooking purposes primarily. The water is pumped from the railway cars to a raised tank, and then distributed to homes and places of business by means of a special pipeline system.

"Each consumer has in his home a special water faucet from which he receives soft water only; this is in addition to the faucet from which he receives the domestic, or 'hard water.' The cost to the consumer for this soft water is at the rate of 1¢ per gallon, and the whole transaction is not only burdensome to the consumers, but the city also suffers a financial loss in furnishing the water. . . .

"According to a report received from the Department of Public Health of the State of California dated Mar. 9, 1955, this water contains 1,200 ppm sulfates (SO_4). The Twining Laboratories have reported to us in this connection: 'According to the standards of the USPHS, the sulfate content of a good drinking water should not exceed 250 ppm, and the total solids should not exceed 1,000 ppm. The excessive concentration of magnesium sulfate (Epsom Salts) gives this water laxative properties. The hardness of the water is very high.'

"An earlier report (1947) from the Twining Laboratories has this to say about the water: 'This water contains an excessive amount of sodium and magnesium sulfates which give it strong laxative properties and make it an undesirable drinking water. It is also an extremely hard water which should be softened if it is to be used as a boiler feed, for washing, etc. However, softening would not improve this water from the standpoint of drinking water. It may be classified

as a fair irrigation water; however, it should be used only on loose soil with good drainage so as to prevent alkali accumulation on the surface of the soil.'

Incidentally, the sulfates (SO_4) content as given in this 1947 report from the Twining Laboratories was 1,042.4 ppm, whereas the report from the state health department, above referred to, gives the sulfate contents as 1,200 ppm.

"This domestic water is received from eight producing wells which the city of Coalinga has drilled. The wells are drilled to depths of from 380 to 1,300 ft. They are produced from an average depth of 240 ft.

"It is relevant to consider that City of Coalinga is located in what is known as the Pleasant Valley Water Basin. In the past, the water level in the basin has lowered from 4 to 5 ft annually. In 1947 the water table was located at about 90 ft; now, as before stated, it is located at approximately 240 ft.

"There are no streams of importance that can be used as a water supply, and it is a fact that with ever increasing farming activities in the basin, water taken from the basin on the basis of prescriptive rights, together with greatly increased municipal water use, will lower the water level rapidly and without much warning. Pumping costs, of course, increase greatly with deeper water levels. Naturally we are vitally concerned about the question of an adequate water supply. At present we believe that there is water available in some degree to about 1,200 ft; we know that there is no water below 1,200 ft.

"The welfare of Coalinga is closely connected with the maintenance of farming at its present level. At present the quality of water pumped is deteriorating with relation to the degree it has become necessary to obtain it from ever lower depths. During the past year some farmers have felt it necessary to abandon some of their properties for farming purposes because of the deterioration of the quality of the water. Also, pumping costs are becoming prohibitive, and we are advised that in some cases, these costs are approaching a point where profitable farming will be impossible.

"It is a fact that under the present pumping load the underground basin is now critically and dangerously depleted. Pumps that were once adequate for the lift involved are now being replaced with costlier pumps that are capable of reaching deeper into the underground basin, and in other cases the pumping level is being constantly lowered. The water obtained at the constantly lower levels is of deteriorating quality to an alarming degree."

Here is an example of a local agency with a problem that will not only require a great amount of initiative but a helping hand to find a solution. Coalinga is currently pressing hard for federal authorization leading to the construction of the San Luis Dam.

The city of Coalinga has already exercised a great amount of initiative in providing its citizens with an unusual dual supply. Certainly no higher agency is voluntarily going to the assistance of Coalinga, so the city itself must continue to exercise initiative in pursuing an ultimate solution. I leave it to you to decide whether or not, in the determination of that final solution, Coalinga will be swayed by the political theory of federal against state control, or will seize upon the first helping hand that it finds extended. This perhaps represents a challenge both to the federal government and to the California authorities.

Conclusion

In conclusion, I should like to suggest that perhaps there might be a way for the continuance of local initiative with the participation and guidance at the state level. A plan might be developed to make cooperative financing possible. Cooperative financing is not unique, but to my knowledge, has not yet been suggested as a means of promulgating the California Water Plan. By cooperative financing I mean a provision whereby state funds could be made available for local construction, perhaps on a 50–50 basis. This would allow local agencies to start on immediate projects, or to plan future developments.

In any event, I am convinced that we who are responsible for the development of water supplies can in no way rest on our oars with the development of a state water plan. We will have to be just as resourceful and bold as in the past and develop even further ingenuity because, although proceeding on our own, we must keep in line with the features of the California Water Plan.

Local Authorities' Part—*William Berry*

A paper presented by William L. Berry, Chief, Div. of Resources Planning, State Dept. of Water Resources, Sacramento, Calif.

A good deal of planning has preceded the major water developments in California, but in general, these developments have been largely on a local or regional basis. We are now at the stage where massive, interregional transfers of water are necessary, as well as many projects to meet more localized water problems. In most instances the interregional projects must serve local needs as well.

I must emphasize that the California Water Plan in no way supersedes local projects required or planned by either public or private local agencies. All such projects are intended to be included in the master plan to obtain maximum integration, but that does not imply that the state proposes to construct such local projects itself. The efforts and resources of all agencies, of cities, of irrigation districts, and others, will be required in building the more than 260 new major reservoirs which will be needed for the full development of the water resources of the state.

The California Water Plan envisions eventual construction of new works on nearly every stream in the state, facilities for interregional transfer of more than 23,000,000 acre-ft of water each year, and the full utilization of our ground water resources.

It would control floods in regions where excess water now wastes to the sea; it would generate hydroelectric power; it would control salinity in major rivers; it would replenish the depleted underground reservoirs; and it would repel sea water from the coastal basins. One of its important objectives would be that of preserving and enhancing our fish, wildlife, and recreational facilities. These facilities are among the most important economic factors of the state. The projects contemplated in the California Water Plan will create new recre-

ational facilities and stabilize many of those now in existence.

It is important to note that the California Water Plan, as it will be presented to the legislature at the 1957 session, will not be a construction proposal. So far, we have not concerned ourselves with matters of economics and financial feasibility, since we have been developing an ultimate plan. Economic justification and financial feasibility will be considered in specific construction proposals to be made later, and based upon conditions existing then.

The details of the means and timing of the water developments envisioned in the California Water Plan are to be left for future determination. To do this, we are now started on the next logical step in planning—the California Water Development Program. This was authorized by the last session of the legislature, and was initiated at the beginning of this fiscal year.

We then become concerned with the matter of who is going to provide water, and at whose cost? Is this one of those services in connection with which we can convince ourselves that, by transferring the financial obligations to the largest and most remote governmental unit, we are avoiding paying our share of its high cost? There are some important points in consideration of that question which I will discuss.

Variety of Interests

In California, there is no question as to which agency is appropriate to handle water development and supply problems. All agencies are. We have a rather large array of governmental institutions, as well as several types of privately owned organizations that have a part in California water development. From the point of view of financing, this is good and probably essential, because of the varying effects of the timing and types of water development needed. From the point of view of the water supply itself, however, we have reached the point at which there must be an end to uncoordinated activities of the many agencies in the water field. We do not instead propose to substitute either the state government or the federal government as a sole water development agency. What we propose is a master plan for coordinating the efforts of all agencies, while still encouraging all of them to participate to the fullest possible extent in the water development program.

Truly, we need the efforts of all, if we are to solve the problems which confront us. Perhaps by relating some of the facts with which we must be concerned in seeking solutions to our own problems, and in seeking our answer to the question posed earlier, we will provide a line of thinking, or at least some experiences which may be of some interest to others.

There is a type of public organization authorized by statute for nearly every kind of water problem. California law includes 30 general acts which authorize creation of various types of districts for the storage, control, and distribution of water, and 40 special acts establishing individual public agencies in this same field. The agencies organized under these acts include 165 irrigation districts, 69 county water districts, 55 reclamation districts, 39 water districts, 35 county water works districts, 19 municipal water districts, and 130 soil conservation districts.

In addition to these there are about 1,460 mutual water companies, 456

commercial water companies, 207 municipal water operations, the Metropolitan Water District of Southern California, one county water authority in San Diego, and fifteen US Bureau of Reclamation projects, plus a large number of public utility water developments.

All of these public agencies are controlled by the voters and have authority to incur bonded indebtedness and to levy a tax rate. Many of these agencies have played important parts in developing the economy of the state, and many are entirely self-supporting in that their costs are carried by water users and property owners within their own boundaries.

In California, which has an area of approximately 100,000,000 acres, only about 7,000,000 acres are irrigated. Financial returns from the irrigated lands, however, constitute more than 80 per cent of the total proceeds from agriculture in the state. Most of these 7,000,000 acres are served by the 165 irrigation districts, which are independent governmental entities, supported by their own tax and water sales revenues.

Past Local Initiative

Other notable examples of self-help and self-support in water developments are seen in three of the largest urban systems in California.

Los Angeles, a Spanish pueblo founded in 1781, first considered the possibility of importing water from the Owens River (250 miles away) as an answer to the increasing needs of the growing city in 1900. By 1904, investigation had proved this to be a sound plan, and the following year the people of Los Angeles approved bonds to finance detailed studies and purchase of water rights. In 1907, the same voters approved $23,000,000 in bonds to finance a project to bring 400 cfs to Los Angeles. The project was completed by 1913 by the city's own efforts.

Within a few years, it became evident that still greater supplies of water would be required. The second step—to extend the Owens Valley line to tap the Mono Lake watershed—was again a step by the city of Los Angeles, acting independently.

When it became evident that the insatiable appetite of the growing metropolis would require still another supply of water, the city became a part of a Southern California effort to reach greater distances than appeared practical for the city alone, and the Metropolitan Water District of Southern California came into being. Purpose of this district, made up of eleven cities at the time of its organization in 1929, was to make a reality of plans which had been studied and debated for many years. These plans had to do with bringing 1,500 cfs from the Colorado River 300 miles to the east. In 1924 the city of Los Angeles filed applications for that amount of water, and in 1925, voted $2,000,000 in bonds for engineering investigation of the Boulder Canyon Project.

The state statute authorizing organization of the Metropolitan Water District was adopted in 1927, and the Boulder Canyon Project Act (Swing–Johnson Bill) was adopted by Congress in 1928—after a 9-year effort. Signing of the Colorado River Compact in 1929 permitted the project act to become operative.

The Boulder Canyon Project established a new concept for federally financed, multipurpose works. Repayment of the entire cost, except the relatively minor portion charged to flood control, was guaranteed by the people of Southern California

through public agencies and private utilities which signed contracts to buy electric power produced by the project. Those guaranteeing the cost of the project by signing power purchase contracts were the Metropolitan Water District, the Los Angeles Department of Water and Power, the Southern California Edison Company, the cities of Glendale, Pasadena, and Burbank, and the California Electric Power Company.

The thirteen cities making up the organization in 1931 voted $220,000,000 for the Colorado River Aqueduct, which was completed in 1941. The Metropolitan Water District has grown by annexation, and now serves virtually all of the South Coastal Plain south to the Mexican border. The district distributes water to its member agencies, which serve agricultural needs, as well as the urban areas.

Just what these actions, which provided enough water and in time, have meant to Los Angeles and Southern California was well expressed by Samuel Morris when he said:

> The magnitude of the rapid expansion of population made possible by an adequate supply and distribution of water, is brought into clear focus by the following statistics: In the decade 1940–50 the population of Los Angeles city increased by more than 500,000, equivalent to that of Cincinnati; Los Angeles county gained more than 1,250,000 people, equivalent to the population of Boston and Milwaukee combined; and the population of California increased by nearly 4,000,000, equivalent to that of Missouri.

Thus, water, developed at a cost guaranteed by Southern California, and transported and distributed in works financed by Southern California, has been the key making it possible for Los Angeles and Southern California to become one of the great metropolitan centers of the world.

The approach of the city of San Francisco to the water problem, has been organizationally different, but again has represented local initiative and energy.

Prior to the gold rush of 1849, the Bay City was dependent on nearby streams and springs. During the gold rush, water was imported in barrels carried by barges across the bay, then distributed by tank wagons. This was probably the first example of transporting water from one watershed to another in California and shows that the problems involved in such interregional transfers are not as new to California as would be indicated by some of the debate taking place now.

San Francisco's first water system was privately owned, but in 1900 the people adopted a new charter, authorizing the city to provide a municipal water system. Investigation was started on possibility of bringing water from the Tuolumne River, 150 miles to the east. As the principal reservoir site, the Hetch Hetchy, was located in Yosemite National Park, congressional action was necessary before the project could be constructed. This was secured in 1913, but it was not until 1934 that the first portion of the project was completed. Meanwhile, the city had purchased the private water company in 1930.

All of this was carried out by bond issues voted by the people of San Francisco.

Brief mention of East Bay Municipal Utility District is appropriate. It is a public agency, formed by the people of several cities and adjacent unincorporated areas along the east shore of San Francisco Bay, and was voted into existence in 1923. Beginning with a $39,000,000 bond issue voted

in 1924, the district has developed its water supply on the Mokelumne River, 93 miles distant. Total bonds voted have amounted to $77,000,000, of which $38,000,000 are outstanding, and the district owns properties and plant valued at $134,000,000. It serves a million consumers and expects to serve more than two and a half times that many people. The district is now considering a new bond issue to bring additional water from the Mokelumne River.

It is interesting to note that in the 16 years since 1940, the number of customers of the East Bay Municipal Utility District has increased 92 per cent, and the gross water consumption has increased 175 per cent. This is indicative of the results of the district's advertising that "water is plentiful for business and industry . . ." in the area served by the district.

Thus we see again the stimulating economic effect of being there with enough and on time in water development.

In the Central Valley of California there are 78 irrigation districts serving 1,650,000 acres of land, plus a large number of land and water companies. Many of them deliver water developed and transported to a point where it is made available to them by the Central Valley Project—a project originally planned by the state, but constructed and operated by the federal Bureau of Reclamation.

These are only a few of the major water development actions in the history of California. We see that local initiative in planning, constructing, and financing has been the major factor in meeting water requirements in such a manner as to place both the agricultural and urban areas in effective competitive positions. Such action has resulted in the development of California to its position as the top agricultural state and in the growth of some of the world's great metropolitan centers.

In 1905, a report by William Mulholland to the city of Los Angeles said:

> Any waters to the extent of 500 cfs that can be obtained in addition to those actually needed for domestic consumption, could be used for the development of highly productive citrus foothill lands immediately surrounding the city. Doubtless these lands, if irrigated, would soon become densely populated suburban additions to greater Los Angeles.

Those were prophetic words. The latest report on land and water use in the Los Angeles coastal basin shows that the trend is well under way, with lands going out of production for citrus and other agriculture in favor of industry and residential use.

Local initiative, competitive in spirit, independent and uncoordinated, has gone far in the development of the water resources which have enabled California to become great.

Present Duties

That much has been done in the past, and it is an impressive record. The question remains: What can local governmental units do now to make deposits in the water bank of California against their future water drafts?

First, they can assist in applying the finishing touches to the California Water Plan itself.

That the people of California and the officials of the many local districts, municipalities, water authorities, and private utilities are willing to do their share has been amply demonstrated during the past several weeks. Nine hearings on the California Water Plan were conducted throughout California jointly by the Department of Water

Resources and the State Water Rights Board. Their purpose was to hear the views of interested parties concerning the preliminary draft of the plan, and to receive recommendations for changes or additions. Response by these public spirited people was at once remarkable and gratifying.

More than 1,500 persons attended the hearings and some 200 statements were either submitted in writing or given verbally. Our planning engineers have pored over these statements and recommendations, and full consideration will be given them in preparation of the final draft, which will be submitted to the legislature in 1957.

Valuable though these contributions were to making The California Water Plan the best possible present instrument for eventually making sufficient water available to all of California, they should not be considered as the end effort in that direction.

Engineers and others concerned with water development must be crusaders, always striving to sell their constituents on the needs 20–30 years ahead although the people may not as yet have felt the pinch of water shortages.

That role must be played by a greater number of local water officials. Public knowledge and understanding of the problem is a vital prerequisite even to getting started on the job. You of the AWWA should strive to keep your people informed of the necessity of a master plan for water development in the state.

In the past, many strictly local projects were planned and constructed with but a single purpose and a single area in mind. In those days of more plentiful water and cheap dam and reservoir sites, such a procedure could be done without too much damage to the overall scheme of things.

Today we can no longer afford such extravagance. One of the limiting factors now is a scarcity of good dam sites which can be developed cheaply. To compensate for their increased cost, these sites must generally be made to work for more than a single purpose and a single area.

Those planning local projects can do a tremendous service not only to their own districts but to all of California if such projects are fitted into the master blueprint, and are planned with objectives of the greatest good for the greatest number of people in mind.

In developing the California Water Plan, local districts and agencies have been of invaluable assistance in providing data and knowledge of local conditions. This assistance can and must be continued in the planning of future local projects.

The state in turn stands ready to assist local entities in carrying out their own objectives in every way possible.

It is probable that to construct certain projects in conformity with the master plan or blueprint may well require works beyond the need or capability of the local agency involved. To bring about construction of such projects at a location and of a size necessary to insure full utilization of the water potential, it may be necessary for the state to participate financially in such locally built and locally operated projects, at least to the extent of the state's interest.

For example, a certain irrigation district is constructing a water supply reservoir large enough to irrigate 10,000 acres. But the potential of the stream on which the dam is to be built is much greater than this. To utilize properly the resource, a larger dam should be built.

But it happens that the irrigation district is financially unable to undertake construction of the larger dam. With state participation, the district would pay for a portion of the dam in relation to the structure originally planned for its own needs and the state would pay for the difference.

I must emphasize that such a plan for state participation is not yet crystallized, but it indicates the direction of our thinking, and there is a possibility it will be presented to the legislature for consideration in a very short time.

We also will welcome federal help, provided it is given within the framework of our state water laws and in accordance with the master plan.

The case histories of local water developments already mentioned demonstrate that local initiative and energy are still very much alive. Aggressive continuation of those admirable qualities, plus cooperation of private interests, the federal government, and the state of California, working through the master plan of water development, cannot fail to solve our water problem.

Financing the Plan—*Bruce F. Allen*

A paper presented by the Honorable Bruce F. Allen, State Assemblyman, State Capitol, Sacramento, Calif.

During my 4 years in the California legislature, I have been particularly interested in water problems because in my own district in the Santa Clara Valley there is a critical water shortage. I have found many other members of the legislature equally interested for similar reasons. As an example of such interest, we now have twenty members on the Joint Interim Committee on Water Problems plus other committees in each house equally interested in our water problems. The legislature has acted on the problem by appropriating funds for detailed engineering studies of our water problems. We have benefited by such reports as the 1951 and 1955 Feather River reports, the American River Basin investigation, the Upper Feather River Service Area, The Bechtel report, the Bay Barrier studies, Bulletin No. 2 on Water Utilization and Requirements, and most recently Bulletin No. 3 on the State Water Plan.

Need for Early Start

Early this year, the legislature had reached the point of completion of these general engineering studies. We then knew that we could meet our water deficiencies in the San Joaquin Valley, Santa Clara Valley, and Southern California by constructing the Feather River Dam, California Aqueduct, and South Bay Aqueduct at a cost of 1½ billion dollars. This sum, unfortunately, staggers the imagination of persons not familiar with the growth and wealth of California. I have had respectable members of the legislature tell me that the state could not afford to spend such a large sum on water development. These same people were really struck by Bul. No. 3, proposing a system of 240 surface reservoirs, to distribute 14,000,000 acre–ft of water each year, in order to meet the ultimate water needs of California. The estimated cost is eleven billion dollars.

The Feather River Project, designed to meet the more immediate needs is proposed in the 1955 report for construction over a period of 31 years, with financing by 40-year general obligation bonds.

As a means of comparison, in order to determine the financial ability of the people of California to pay such a cost, consider this: the Pacific Gas and Electric Company, a single private utility in Northern California, invested over a billion dollars of private capital in its facilities in a few years following World War II, in order to keep up with the growth in Northern California alone. The state budget has now reached an annual total of 1.779 billion dollars. The new budget for the Highway Commission for 1957–58 is in the amount of $441,000,000. The operation of our Department of Fish and Game will cost this year $8,262,000 in state funds. At that rate and with no increase, California during the 70-year construction and bond payout period of the Feather River Project will spend over $578,000,00 on our Fish and Game Department alone.

By comparison with existing state supported programs, the Feather River Project, and even the entire state water plan, is relatively minor in size.

On the other hand, the economic benefits to our entire population from adequate water supplies are tremendous. Irrigation of a million acres of California's fertile but often arid soil will produce at least $250,000,000 per year in new wealth, money which funnels into all channels of trade and benefits every person in California. New subdivisions and new industrial plants depend on a continuous supply of good water.

One of the serious problems that has plagued our efforts to solve our water shortage is finances. This has been met initially by local districts or city bond issues. In my own county, we have constructed a series of water conservation dams and percolation facilities with local bond issues. We could, if necessary, go to the Sacramento River or further for additional water, but it is beyond our capacity to construct the major works such as the Feather River Dam or Sacramento River diversion canals that are required to give the necessary supply in the delta area. The same problem applies to other areas including even the large Metropolitan Water District of Southern California. The problem is statewide and must now be solved by a coordinated statewide plan. California is now a unit where water is concerned. Recognition of this principle is basic to any solution of our problem.

Federal Financing

The federal government has been most helpful in producing funds for construction of water projects in California. Federal appropriations to the Bureau of Reclamation for the Central Valley Project alone since 1937 have totaled $465,680,289, an average annual congressional appropriation of $23,284,000. Congress stepped up the rate somewhat in the last 10 years, however, averaging $29,150,000 per year. Some of the beneficiaries of this program have had complaints, such as the fact that Uncle Sam expects to be paid back for these projects. In effect we pay for all federal projects twice, once through our federal taxes, and again through the 40-year repayment. This program has resulted in construction of tremendous facilities that help meet our needs. However, notwithstanding this federal construction, we are further behind now in solving the water

problem than we were when the Central Valley Project started. The overdrafts on our underground water supply are greater today than in 1937.

We simply cannot afford to wait for the federal government to take care of our water problems. We can and must outline the plan for development of our water resources and build a major part with state financing assisted to the maximum possible extent by federal and local financing.

The presently authorized unfinanced federal projects in California add up something like this:

Completion of authorized Central Valley Project units	$ 20,000,000
Completion of Monticello Project	$ 55,000,000
South Canals	$ 57,000,000
Santa Maria Project	$ 17,000,000
Ventura Project	$ 27,000,000
Trinity River Project	$225,000,000
Total	$401,000,000

The exact amount of these figures will not be known until completion of these projects. At the past rate of financing ($29,150,000 per year), Congress will take over 13 years to complete the financing. The figures do not include the $220,000,000 San Luis project which has not yet been authorized. Federal appropriations vary greatly from year to year. However, these figures do show a large backlog for presently authorized but not as yet financed federal projects.

Revenue Bonds

The 1951 Feather River Project proposed financing with revenue bonds. This was authorized by the legislature in 1951, but the Water Project Authority never moved on this authorization. Revenue bonds are impractical for this type of project. Such bonds could not be sold without proof to the bond purchasers of firm contracts for sale of water and power on fixed delivery schedules at prices high enough to meet amortization of the bonds. Such contracts cannot be obtained from water users in advance for projects that take 6 to 20 years in construction. The interest rates on revenue bonds average about 1 per cent higher than general obligation bonds, which adds to the cost of the project and the cost of the water.

The 1955 Feather River Report proposes financing with general obligation bonds. The interest charges on the bonds would add another billion dollars to the cost of the project. This must be added in to the price charged for water. That price must furthermore be high enough to amortize the cost of the project during the 40-year bond period, of which only 30 years is the repayment period. This means that we are talking about imported, supplemental water which is expensive. Farmers in my own district would gladly have paid $22 an acre–ft, as proposed for this water, last year when we had a severe drought. This year, however, we had ample rains and a better supply. It would be a needless waste for us to pump in expensive imported water in years of abundant local rainfall. The fixed delivery schedule required to amortize these bonds is a hardship on the users and another obstacle to the project. Such a bond issue must go on the ballot, statewide, would be the subject of great controversy, and requires a 2-year delay to get voter approval.

Pay-as-you-go Financing

Another method of financing our state water plan is on a pay-as-you-go basis. That is the way Congress finances works of the Bureau of Recla-

mation or the Army Engineers. It is the way we are financing $85,000,000 worth of state buildings this year. By way of further comparison, we spend $92,000,000 a year on mental hospitals, $108,000,000 in state funds on the old age pension, and $525,000,000 this year in payments to local school districts for public education. These are all worth-while programs financed by state funds on a pay-as-you-go scheme. If we can afford them, then why can't we afford to build a water system as a permanent state investment in the future of California?

Pay-as-you-go financing eliminates all interest charges, which means lower water rates. There is no need for a fixed amortization schedule, and no requirement that water users take imported water on a uniform annual basis regardless of local need. Deliveries through the California Aqueduct could be made as needed. High water prices are an economic barrier to growth of any community. With pay-as-you-go financing, water prices can be based primarily on the cost of pumping, operation, and maintenance of the system plus a small repayment charge. If a uniform repayment charge of $1.50 per acre-ft is required, high quality water can be delivered through the Feather River Project at the following prices per acre-ft.

Sacramento Valley	$ 3.00
San Joaquin Valley	5.00
Santa Clara Valley	6.50
Los Angeles-Riverside	15.00
San Diego	24.00

This program calls for abandonment of the old theories of repayment, which are applicable to projects of peculiar local benefit, but should not apply to the major water system proposed in the State Water Plan.

These major statewide works benefit the whole state. Long Beach will benefit from an adequate supply of water to San Joaquin Valley farms. On the other hand, a severe water shortage in San Diego adversely affects the level of business and prosperity in Los Angeles and San Francisco.

Pay-as-you-go financing will make possible greater tunneling and use of lower pump lifts, and perhaps even a complete gravity flow system. Present designs are influenced by the requirement that the engineers meet the amortization cost of the project on a bond issue that is paid out in 30 or 40 years. Pumping charges and their demand on our electric power supply will go on forever.

Additional reasons, apart from water problems call for a pay-as-you-go program. California has received $122,000,000 in accumulated oil revenues from the Long Beach tidelands under terms of a bill passed unanimously by the legislature in April 1956. Further millions in oil revenues are coming into the state treasury from state tidelands oil production each year. These funds are from a natural resource that diminishes as the oil supply becomes exhausted. If allowed to fatten our appetite for the everyday cost of government, future taxpayers will have an even bigger burden to bear when these oil funds are no longer in the treasury.

Funds available to the legislature for water development and not already committed to other programs are as follows:

General fund cash surplus ($130,000,000)	$ 50,000,000
Long Beach oil trust fund	$120,000,000
Rainy day fund	$ 75,000,000
Total	$247,000,000

This money, coupled with possible flood control contributions from Con-

gress, could make a good start on the state water plan. Annual funds available for further development could be as follows:

Long Beach oil and gas income	$16,000,000
State tidelands oil and gas income	$30,000,000
General fund	$25,000,000
Power revenues—Oroville	$14,000,000
American River	$19,000,000
Total	$94,000,000

These figures will vary, depending on the attention that is given to the state share of these oil revenues. Unfortunately, there has been a decided reluctance on the part of the Attorney General to protect the state treasury as concerns either the city of Long Beach, squatters on the Long Beach tidelands, or other oil operators draining the state tidelands. The new Shell-Cunningham tidelands leasing act opens up millions of acres of state tidelands at ridiculously low revenues to the state. The State Lands Commission has shown remarkable speed in leasing key parcels under this act before proposed changes could be considered by the legislature. There is too much emphasis on pleasing the oil companies and not enough emphasis on getting the maximum returns to the state.

This pay-as-you-go program is within easy reach of the legislature and the people of California. Application of these funds to immediate construction will break the log jam of water development that we are facing in California. Every effort to date to get the state started on a construction program has been blocked by sectional battles over water rights.

Present Disputes

These water rights questions are not concerned with the right of the state to these surplus waters, but center principally around the counties of origin. These counties look with fear on the wasteland in Mono and Inyo counties and justifiably ask some protection. Their modest needs will be met only by a state construction program. The mountain counties need water projects just as much as we in the deficient areas. Expenditures of a few million dollars to build those water projects in the mountain counties will be a complete answer to their demands. As far as the rest of the state is concerned, every engineer I have heard on the subject states there is ample water in California to meet our foreseeable needs all over the state. If we build our water projects, we are sure there will be ample water to meet the needs. On the other hand, if we tie our hands with constitutional allocations of water rights to some areas in excess of reasonable use, we are going to be in serious trouble.

The whole controversy over the counties-of-origin law is based on a theory of scarcity, of water shortage, that does not exist. The emphasis, in a state with the greatest water need and the greatest amount of water going to waste, is presently on the skilled water rights attorney. Such men have their place, but not in the front rank. This battle should be settled, not in court, but on the business end of a power shovel. What we need is a straight utility concept in water rights under the state water plan. It is possible and feasible, according to all the experts.

In summary, I urge that we build the California Water Plan as rapidly as possible on a pay-as-you-go basis, earmarking Long Beach and tidelands oil revenues for that purpose plus some general fund revenues, that water prices be set at slightly above the cost of operation and maintenance,

that we encourage local and federal participation, and that only in this way will we solve the water rights question in California.

Flood Control Problems—*William F. Cassidy*

A paper presented by Brigadier General William F. Cassidy, Div. Engr., South Pacific Div., Corps of Engineers, US Army.

Effective flood control cannot and does not start when the storm occurs. Flood control requires advance planning by water works men and their communities as well as by the state and federal flood control agencies. Of equal importance is the need for advance planning of development of water supply requirements in conjunction with flood control.

Those of us interested in water know that it is our most precious resource. The water works profession is a practical, farsighted group dedicated to the purpose of providing water in adequate quality and quantity to an ever expanding population.

The Corps of Engineers is dedicated to similar aims. By law, Congress has directed that the federal government should undertake flood improvements or participate in them if such projects are economically justified; that is, if the annual benefits exceed the annual cost. Implementation of the law requires that when a flood control study is undertaken, that study will include full development of all water resources engineeringly feasible and economically justified. The Corps of Engineers, therefore, becomes immediately interested and active in the conservation and proper utilization of water for domestic supply, irrigation, fish and wild life preservation, recreation, and all other uses.

California is not alone in the water problems it faces. The nation's water supply problem is a most serious one. The nationwide demand for water is constantly growing. In fact, the demand has reached such proportions that the most critical single water resource problem facing the nation is that of providing an assured adequate supply of water for future domestic and industrial needs. The Corps of Engineers recognizes the seriousness of the problem, and hopes that with the help of those in water works, everything possible to improve the water supply whenever a flood control problem is under study, will be done.

It seems very certain to me that, as the search for and development of our limited water resources intensifies because of an almost explosive demand, all agencies concerned must cooperate and work together for the attainment of our common goals. Most of the easy projects have been built. Those left are large, complex and expensive. They involve optimum development of water resources for many purposes. Thus, it is necessary that the agencies of the federal government, the state, local governments, irrigation interests, and the water works people work together.

With these thoughts in mind, a brief sketch of the historical background of the Corps of Engineers in water resources development may be of significant interest.

Historical Background

The Corps of Engineers' history dates back to Jun. 16, 1775. It was

President Jefferson, however, who first established the policy of assigning to the Army Engineers various peacetime duties of a civil as well as military nature. He sent them into the western frontiers to survey and report on requirements for roads, canals, bridges, and other civil works.

In the ensuing years, the cumulative results of specific authorizations by Congress brought about the present civil works program, under jurisdiction of the Secretary of the Army and supervision of the Chief of Engineers. Flood control as a federal policy came into being with the general flood control act of 1936. The overall program includes improvements for navigation, flood control, and related water resources development. It also involves shore protection works which are studied and considered by the Beach Erosion Board. In addition to my duties as division engineer, I am a member of that board.

The program is administered by the Corps of Engineers by means of a highly decentralized organization which has been developed over the years. In geographical scope, this organization covers the continental United States and its overseas territories and possessions. The continental United States is divided into eleven divisions and each division is normally divided into several districts. The districts of the South Pacific Division, which I head, are at Sacramento, San Francisco and Los Angeles. The area covered is roughly the states of California, Nevada, Utah, and Arizona.

Every civil works project proposed for planning and construction under federal policy must be initiated by local interests. The Corps of Engineers does not initiate any project. Projects so initiated by local interests are authorized by Congress under a procedure developed over more than a century. It consists essentially of three major steps:

1. Congressional authorization of specific investigations and reports
2. Congressional authorization of specific projects and plans of improvement
3. Congressional appropriations for construction.

The detailed process is a very democratic one; it begins at the "grassroots" in local communities. Throughout its course, the process is closely tied to the needs and desires of local people. Between the local request for a study and the finally completed job there are 25 steps. I will not take time to detail these steps. However, before starting his studies and usually after completing them, the responsible district engineer holds public hearings to find out what the people want; whether his solution is satisfactory to them; and if they will give assurances that they will provide, at their expense, the local cooperation required by law. The report is reviewed in turn by the division engineer, the board of engineers for rivers and harbors, the governor of the state, other interested federal agencies, the chief of engineers, and the US Bureau of the Budget. When it has successfully run this course, it is presented to Congress for project authorization.

After authorization of the project and appropriation of funds by Congress, the district engineer prepares a definite project report. After this has been reviewed and approved by the division engineer and the chief of engineers, contract plans and specifications are prepared, competitive bids taken, award to the successful contractor made, and the job is constructed.

The extent to which local interests should contribute to federal flood con-

trol work, the manner in which investigations are carried out and reported to Congress after complete coordination among affected states and agencies, and the consideration of comprehensive development of water resources in conjunction with flood control are all matters which are governed by law.

National Program

It has long been recognized that flood control is merely one of the purposes for which our water resources should be developed. The national flood control program, excluding for the moment the multipurpose improvements, involves over 760 projects with a total estimated cost of 6.3 billion dollars. Of this amount, 2.6 billion dollars has been appropriated by Congress, leaving a total of 3.7 billion dollars for completion. If the 40 multipurpose projects which also serve flood control are added, the estimated cost of the total program becomes 9.5 billion dollars, of which a total of 4 billion dollars has been appropriated through fiscal year 1956.

The accomplishments of the flood control program have more than justified its cost. The projects in full or partial operation are preventing flood damages of one-half billion dollars a year, and, in addition, are producing related benefits of one-quarter billion dollars a year. This total annual benefit is being achieved at a cost slightly more than $200,000,000 a year. The flood control program is paying off at the rate of more than $3 for each $1 invested. This does not take into account the values which cannot be measured in monetary terms, such as the saving of life, and economic security of hundreds of communities and farming areas.

The Corps of Engineers recognizes that much is still to be done in the field of flood damage prevention. The potential flood losses in the US in the main river valleys and the major tributaries would amount to $900,000,000 a year if there were no flood control works. The reduction of $500,000,000 a year being achieved by flood control works now in operation still leave a balance of $400,000,000 of annual average loss and provides some measure of the work that still lies ahead of us. Constant need exists for review and re-analysis of the program and for authorization of modifications and additions, not only because of the occurrence of major floods which may require changes in a river basin plan, but also to keep pace with technological and economic changes which may have occurred after the approval of individual projects or basin plans. The flood control program, like our country, is dynamic, growing, and changing. To accomplish the program requires an accumulation of more knowledge of the behavior of streams and floods, and the engineering tools to control them.

California Program

The presently authorized flood control program in California comprises 41 projects, ranging in size and scope from small local protection works to very large basin projects such as the Los Angeles County Drainage Area project and the Sacramento River Flood Control project, as well as several large multipurpose reservoirs. The presently estimated total federal cost of the 41 projects is $860,000,000 for which Congress has appropriated about $448,000,000. Of these projects, sixteen are completed and in operation; 21 are under construction

and planning, and several of these are under partial operation; four have not yet been started.

Time does not permit an enumeration of all of these works, so that I shall only give a brief sketch of some of the most noteworthy of these projects.

In San Diego, the city and the Corps of Engineers have built a flood control, navigation, and public recreation project. The Corps of Engineers built the flood channel for the San Diego River and the navigation entrance and mooring area to Mission Bay. San Diego is doing the rest. When finished, it will be one of the finest aquatic parks in the country.

The Los Angeles County Drainage Area Project covering the Los Angeles and San Gabriel River and Rio Hondo basins is one of the largest urban protection projects in the country. The federal share of costs is estimated at $338,000,000, of which Congress has appropriated about $163,000,000. It is about 40 per cent complete, and the completed portions are being operated for flood control now. The plan provides for five large flood control dams, 33 debris basins, 105 miles of concrete-lined channel, 181 miles of tributary channels and many supplementary structures.

In the Central Valley there is the Sacramento River Flood Control Project, Folsom Dam and Reservoir, Pine Flat Dam and Reservoir, and Isabella Dam and Reservoir. On the Russian River, near Ukiah, is Coyote Dam and Reservoir, now under construction. This is the first multipurpose reservoir in the north coast area of California, and the first unit in the comprehensive plan for development of Russian River.

Flood Control Accomplishments

You no doubt have vivid recollections of the devastating storms and floods which struck northern California and the Los Angeles area in December 1955 and January 1956. These were the most widespread and destructive of any floods in the recorded history of Northern California since the legendary floods of 1862 and 1867. The dollar value of damages suffered along the north coast, the Central Valley, western Nevada and in Los Angeles County from these floods totals $180,000,000. That figure is startling but does not convey the grim realities. Sixty people were drowned and others died as a result of exposure. Sixty or more communities from villages to large cities were hard hit, four were destroyed. Over a million acres of agricultural land were flooded and some 12,100 head of livestock were drowned.

The constructed flood control projects previously discussed, together with the Shasta and Friant Reservoirs of the Bureau of Reclamation prevented damages during these floods of $218,000,000. Of this huge value saved, the Los Angeles County Drainage Area Project accounted for $55,000,000 and the Sacramento River Flood Control Project for $105,000,000. This is a handsome dividend on the flood control investment. Many of the projects saved considerably more than they cost in this one flood.

Nine authorized reservoir projects not yet constructed would have prevented damages estimated at $71,000,000, had they been in operation in December 1955. This list includes the great Oroville Dam and Reservoir on the Feather River authorized by

the state of California for construction by the state. That structure alone would have saved Yuba City and prevented damages of $50,000,000.

Authorized levee and channel improvement projects would have prevented an additional $10,000,000 in damages had they been completed in December 1955.

Summarizing the foregoing estimates, we found the constructed flood control works prevented damages of $218,000,000, and the authorized projects not yet constructed would have prevented, had they been built, an additional $81,000,000. The total is $299,000,000 in flood damages prevented or preventable in this one series of floods. This gives an emphatic yes answer to the question "Does flood control pay?"

An analysis of the flood damage reports of the December–January floods also brings out very clearly that the flood control job still has a long way to go in California before all cities and areas have been provided the protection they should and ultimately must have. Deducting the preventable damage from all authorized, recommended, and proposed projects from the damage actually suffered leaves a balance of some $92,000,000 for which no alleviation has as yet been proposed. Of this, it is estimated that 10–15 per cent would not be preventable. We still have left some $78,000,000 of preventable damages. To the alleviation of this problem, our future attention must be directed.

A very substantial part of the unsolved flood problems lie in the north coastal areas. However, trouble spots remain along the central coast, in the San Francisco Bay Area, in the Central Valley and in western Nevada.

Investigations and Reports

As previously described, the first requirement toward attaining authorization of a flood control project is the preparation and submission to Congress of an authorized survey report on the problem, with favorable recommendation. Congress has previously authorized surveys for flood control and water conservation on most of the river and stream basins in California on which flood problems still exist. Since the outbreak of the Korean war, funds for these studies have been meagre. More generous funding of these studies was appropriated in fiscal year 1957, and it appears probable that an accelerated rate of progress will be made in the years immediately ahead.

At this time, some 46 flood control survey and review reports have been authorized in California. Of these, about 20 are being actively prosecuted by our district staffs. It is expected that these studies will result in favorable recommendations on a number of streams where flood control works can be economically justified.

From the statistics I have given, it is obvious that a flood control program does pay dividends; that a serious flood control problem still exists; and that though a partial solution is being planned, additional planning remains to be done.

It is in the planning for solution to flood control problems where those of you who are interested in municipal and industrial water supply can play an important role. To illustrate, I refer again to Coyote Dam and Reservoir near Ukiah.

Cooperative Development

Flood control is the primary purpose of this multipurpose structure.

However, studies indicated that conservation of water for municipal and industrial water supply and also for irrigation and other related purposes would be feasible under a comprehensive plan of development.

The costs of water resources projects under the jurisdiction of the chief of engineers are shared between federal and nonfederal interests. Where storage for municipal and industrial water supply is made available by multipurpose projects, water users are required to pay the cost allocated to such storage. The Appropriations Act for fiscal year 1938 authorizes the addition of water supply storage, providing that water users pay for the extra or incremental cost of adding it. Under the Rivers and Harbors Act of 1944, the Secretary of the Army is authorized to dispose of "surplus" water for domestic and industrial uses at such prices and terms as he may deem reasonable.

In the case of Coyote Dam, local interests took up the challenge and requested that water conservation features be incorporated in the plans. After thoroughly debating the pros and cons, a bond issue of nearly $6,000,000 was voted to cover the cost of including water supply storage. Further evidence of their farsightedness and faith in the ultimate development of their area was demonstrated when they voted another bond issue of approximately $8,000,000 for the cost of transmission lines necessary to get the water from Coyote Reservoir to their desired points of distribution. I point to this enterprising community because it is an example of what can be accomplished under a comprehensive water plan.

The natural runoff in a large portion of our state is still an almost untouched resource. From year to year, as a result of population increases, our virile economy, and as technological analysis predicts the acceleration of water consumption and control, the planned development of this resource will require expanding. California has taken a major step in planning development of its water resources as elements of a unified, comprehensive program. It is a step which, I believe, will be followed by other states when they too recognize that water resources needs are not separate and divisible. The control of surface water for preventing floods and conserving it for domestic, industrial, irrigation and other needs, including pollution abatement, navigation, and the generation of power, is one indivisible problem and must be so approached. All agencies must work toward fitting the solution to their water resource development problems into the overall California Water Plan.

I wish to emphasize that the Corps of Engineers intends to coordinate and integrate all plans that may be recommended for authorization in this field with the State Department of Water Resources and the California Water Plan. Only in this way can our efforts be made to serve Californians in the most effective manner.

——Federal Service and the Plan—*Clyde H. Spencer*——

A paper presented by Clyde H. Spencer, Regional Director, US Bureau of Reclamation, Sacramento, Calif.

For over 50 years the Bureau of Reclamation has been assisting in the development of water resources of California. Works so far constructed by the bureau within this state represent an investment of over $800,000,000. Construction started on the first federal reclamation projects in California—at Orland in the Sacramento Valley and at Yuma on the Colorado River—shortly after the passage of the Reclamation Act in 1902. Soon thereafter work was begun on the Klamath Project to serve an area in Northern California and Southern Oregon. In succeeding years, Hoover and Parker dams were built to provide sources of water and power for Southern California, and flood control for the Imperial Valley. Also to serve Imperial Valley the All-American Canal was constructed.

The initial units of the Central Valley Project, Shasta and Friant dams, Delta-Mendota, Friant-Kern, Madera and Contra Costa canals and related features including power facilities have been completed and are in operation. Folsom Dam and power plant also are operating as important additions to the Central Valley Project.

The Cachuma Project in Santa Barbara County is essentially completed and has been placed in operation.

Now under construction are the Sacramento Canals and the Trinity River Division—both additions to the Central Valley Project—and the Solano Project, southwest of Sacramento. We are also constructing the Ventura River and Santa Maria Projects in Ventura and Santa Barbara Counties.

Today large areas of land in the Imperial and Coachella valleys, the southern coast, the Central Valley, and in Modoc County are irrigated through projects constructed under federal reclamation laws. Some 7,000,000 acres of land in the west are irrigated through works of the Bureau of Reclamation. An important part of California hydroelectric power comes from Shasta, Keswick, Folsom and Hoover power plants. A substantial degree of flood protection, municipal and industrial water, recreation, navigation, fishery, and other purposes also are being served.

Although the Bureau of Reclamation's contribution to water development in California has been large, other agencies in the aggregate have done even more to make California the progressive state it is in this field. Outstanding examples of local developments include those constructed by the city of San Francisco, East Bay Municipal Utility District, Modesto and Turlock Irrigation districts, organizations along Kings and Kern Rivers, the city of Los Angeles, and the Metropolitan Water District of Southern California.

The contribution of the Bureau of Reclamation during the past 50 years has been mentioned only as an indication of the extent of interest already clearly expressed by the federal government—through that agency alone—in California water developments.

Bureau Aims

Constructed water development projects operated to achieve their designed purposes is the goal toward which all

of the bureau's activities are dedicated. The Bureau of Reclamation since its inception has been and remains primarily a conservation agency. Careful and detailed planning is a prerequisite to any construction, and the bureau has been active throughout the state in this field since 1902. This planning is directed toward getting immediately needed projects under construction. Assurance needs to be provided, of course, that these projects fit as necessary into a long range plan or that they will have served their purpose fully and can be retired when longer range needs require satisfaction. The Bureau of Reclamation is a conservation agency in the fullest sense of the word. It cannot endorse a proposal which provides for partial development at the expense of foreclosing full economical development. The ultimate cost of any partial development of that nature is borne largely by the state itself in terms of lost economic opportunity. The Bureau of Reclamation is proud of its construction record, which forcefully shows what can be done when local interests are in agreement and are willing to meet conditions established for federal participation in projects.

Most Californians are familiar with the principal provisions of reclamation law and policy. In brief, these provisions embody the antispeculation considerations (including the so-called acreage limitation), the requirement for repayment of reimbursable charges (including the desirability of obtaining repayment contracts prior to initiation of construction), and the necessity for full economic justification of the proposed projects.

During the 1920's and the early 1930's, California performed perhaps the most comprehensive job of overall water resources planning which had been undertaken anywhere in the US at the time. The result of this planning was presented as Bul. No. 25 (*1*). One of the most important portions of that plan—the works initially proposed for construction within the Central Valley—subsequently were built as the Central Valley Project. Other units were proposed for future development and some of these, as previously indicated, also have been constructed by the bureau. This construction by the Bureau of Reclamation of certain units included in the State Water Plan, as proposed to the legislature approximately 25 years ago, was made possible because the people of California and their representatives desired that the federal government perform that service.

Current Activities

Over the past 8 years the state government of California again has been most active in water resources investigations. A proposed new California Water Plan now has been presented in preliminary report form. This plan embraces all sections of the state and includes existing water resource development works. Essentially, this plan is proposed as a guide with respect to major developments which will be required to meet the water needs, and not as an all-inclusive definite set of project proposals. Existing works such as Central Valley Project and other features are included in the plan, and they will require carefully coordinated operating considerations in relation to additional facilities.

The Feather River Project now is proposed as the initial unit of the California Water Plan. This project, authorized by the legislature, is estimated to cost about 1.5 billion dollars and is now under more detailed study looking toward initiation of construc-

tion. The Feather River Project includes the prospective San Luis Reservoir which the bureau has been investigating extensively for several years as an addition to the Central Valley Project. It is understandable that the Central Valley Project and the proposed Feather River Project are related to each other. Coordination of the uses of all available water supplies within the state are essential for maximum future benefits. In this regard, state and Bureau of Reclamation representatives now are engaged in cooperative studies to determine the most effective method of developing this reservoir so that it may provide optimum water conservation service. We hope that these efforts will be fully satisfactory.

The Bureau of Reclamation's proper role in water resource development in California is to carry out whatever a united California population wants within the framework of existing Reclamation laws. Yet how united can Californians be on a subject so complex and so vital as water development? This question is yet to be answered in the results of current discussions of Bul. No. 3 (*2*). The Bureau of Reclamation will not take part in future development, and would not be permitted to take part even if it wished, if proposals advanced by one group in the state produced great opposition from others.

Trouble Spots

Two aspects of the current California scene, other than those already mentioned, are important in appraising the bureau's role in water development. In water laws and their administration, the reclamation act of 1902 has, for over 50 years, governed our operations. That act requires that we follow state water law. This has been done and will continue to be done. As the state laws change, the Bureau of Reclamation will follow. There is great need, however, for the state itself to act in straightening out its water law and the administration of that law. After 34 years of continuous water development work in other western states, I have found my 3½ years here to be too short to understand the administration of water rights in California. About the best view I have as of now is that a water right claim is a ticket of admission to a lawsuit. I hope the new Water Rights Board will be able to change this picture.

The second aspect of the current scene which concerns the bureau is the work on Bul. No. 3. An immense job has been done, and knowledge of the state's water supplies and needs has been greatly enhanced by the work underlying that bulletin. I believe it would be better to drop the whole idea of a California Water Plan now than to allow it to form a strait jacket on future development. I need only remind you that the State Water Plan of 1930—marvelous as it was when printed—may have been out of date in many respects by the end of 1931. It most certainly was out of date by the end of 1934. In that case, climate caught up with the planners—and the structures which would have done a given job through recurrence of water years prior to 1931, just could not have done that job through 1934. The California Water Plan of 1957 may be a more comprehensive job, but it too will begin going out of date as soon as it is published. I hope it will be kept current—and that no engineer of the 1970's or 1980's has his proposals of that day judged by the studies and conclusions of the 1950's. Population changes, water

needs, water supplies, new techniques and, above all, change in economic conditions and political attitudes will make changes mandatory. We in the bureau will work within the framework of the California Water Plan just as all other water agencies will work. When the plans and ideas it carries fit the case in hand we will adopt them. When these plans and ideas will not fit, we will recommend changes in them. I am sure everyone else will do the same.

The reclamation program belongs to the people of the western states and the federal government is participating because of the clear national benefits which accrue from it. In reality it is not the program of either the Bureau of Reclamation nor the Department of the Interior. These agencies of government are merely the hired hands in carrying out the wishes of you—the people of California—and the other sixteen western states as they are expressed through the Congress.

References

1. Report to the Legislature of 1931 on the State Water Plan. Bul. No. 25. Div. of Water Resources, Sacramento, Calif. (1931).
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— Legal Questions to Be Answered—*Wallace Howland* —

A paper presented by Wallace Howland, Asst. Attorney General, State of California, Sacramento, Calif.

Three things occurred during the 1955 general session of the legislature which are still under discussion today: First, the attorney general issued an opinion upholding the constitutionality of two statutes which relate to the so-called "counties-of-origin problem." Second, the Division of Water Resources published its report and plans for the Feather River Project. Third, numerous bills were introduced to modify or repeal the present laws which reserve water to those parts of the state in which our surplus water originates. Representatives of Southern California have consistently taken the position that some modification of the present statutes must occur before they can, in good conscience, support actual construction of the Feather River Project.

Interim committees of the legislature are studying this question, as are at least two other groups of informed people. Over a year ago the attorney general sought and obtained the assistance of a group of some eighteen outstanding water lawyers of the state in analyzing the problem and its solution. At about the same time the State Chamber of Commerce appointed a subcommittee for the same purpose. Both of these committees are hopeful of filing their reports and recommendations in the very near future. As I have the honor of being a member of both of these committees it should be noted the opinions expressed in this article have not been authorized or approved by either committee. The views which I am about to express are simply my own as the representative and assistant of the attorney general.

History

The situation with which we are confronted today can best be understood in its historical background.

The county-of-origin problem arose more than 30 years ago at a time when the bottom lands in the valley of the Sacramento River were developing at a very rapid pace. The law concerning appropriative water rights is founded on the principle that "first in time is first in right." In the Sacramento Valley during the 1920's, many appropriations were made for irrigation purposes and to serve the municipal requirements of the valley towns and cities. In the meanwhile, at elevations above 1,500–2,000 ft, the beneficial use of water was increasing much more slowly than down in the valley floor. The vesting of downstream rights became a matter of great concern to the mountain counties from which flowed the water thus being appropriated. They demanded some reservation of water for their future needs. In a very real sense it was the same type of situation which at about the same time led to the formation of the Colorado River Compact.

The legislature struggled with the problem for 6 years. In 1931 it enacted Sec. 10505 of the water code. This section provides that state-filed water cannot be assigned unless the county in which the water originates has reserved part of the water earmarked for its ultimate development. This statute is today known as the County-of-Origin Law.

County Limits

Two things about this statute should be emphasized. The first is that the geographical area to be protected was deliberately defined along county lines. This was not the arbitrary political description of the area to be protected that it might seem at first glance. Bear in mind that the whole argument started between the mountain counties and the counties in the floor of the Sacramento River Basin. It related to each of the major tributaries of the Sacramento River and, particularly, to those on the eastern slope of the valley. What was wanted was some division between the upper reaches of these streams and the downstream areas on the same watercourse. It just so happens that county lines serve this purpose.

For example, Plumas lies upstream from Butte County on the Feather River; Sierra lies upstream from Yuba County on the Yuba River; El Dorado and Placer lie above Sacramento County on the American River; Amador and Calaveras lie above Sacramento and San Joaquin counties where the Consumnes and Mokelumne rivers are concerned; Calaveras and Tuolumne lie above Stanislaus County on the Stanislaus River; and Mariposa lies above Merced County on the Merced River.

Even today, this designation of the county in which water originates as the area to be protected serves a continuing purpose. Any new formula or modification of the present law must deal squarely with this problem. It is trite but true statement to say that if people in these areas do not obtain water from the very mountain valleys in which they live they will not get it from any other source.

Water Rights

One should also note that Sec. 10505 deals only with the legal right to water naturally flowing in the stream bed. This follows from the fact that Sec. 10505 concerns itself solely with the terms upon which a state filing to appropriate water can be assigned.

When the State Water Plan was still in the process of formulation in 1927, the legislature directed that the

state should file applications to appropriate any water which was deemed necessary for the purpose of the forthcoming State Water Plan. These state filings were intended primarily as a means of securing compliance by all persons with the State Water Plan. The very same act which first directed the making of such filings also contained what is now Sec. 10504. It provides for the assignment of a state filing upon the sole condition that the water is to be used in a manner consistent with the State Water Plan. The purpose which thus underlies state filings should be borne in mind. Within the past year, additional state filings covering some 30,000,000 acre-ft of unappropriated water in the north and northwestern parts of the state have been made in anticipation of the new California Water Plan. As already mentioned, these state filings are nothing more than applications to appropriate water to which no vested right exists. They relate to the undeveloped runoff which exists in the bed of a stream flowing in a state of nature, and it is through the medium of the control which the state has over the assignment of its own filings that the protection granted to counties of origin is made effective.

There is much talk today about the reservation of water rights. Those who are not lawyers frequently miss the point of the distinction between a water right and a right to a water supply. Any citizen who lives in a service area of a public utility engaged in the water delivery business has a right to be served with water and to continue receiving that service. This, however, is not a water right as that term is known to the law. As you doubtless know, water rights may be of several kinds. They may be riparian, appropriative, overlying, or prescriptive. However, they all have one thing in common. They assume that the forces of nature have made water available at a place where and at a time when the person can capture it and put it to use. That is to say, there is no human agency standing between the water user and the forces of nature which make the water available to him. The situation of the owner of a water right is entirely different from that of a water user who receives his water, not directly from mother nature, but from a man-made distribution system involving storage reservoirs, pumping stations, canals, aqueducts, pipelines, and all the other physical works which contribute to such a delivery of water.

In summary, Sec. 10505 has the effect of reserving a water right—that is, a legal right to the use of undeveloped water flowing naturally in a stream bed—to the county in which that water originated in the form of precipitation falling upon the land. It has nothing to do with the delivery of water from a water storage project. It concerns primarily the respective rights to the use of water as between upstream users in a mountain county and other users who are located downstream from that county in the same watershed. Its practical application is chiefly a matter of concern within the various watersheds of Northern California. This is the first aspect of the overall problem.

Central Valley Project

Two years after Sec. 10505 was adopted, the legislature passed the Central Valley Project Act of 1933. At that time it was expected that the state would build and operate the Central Valley Project. As you all know, the project was intended to deliver surplus waters from the watershed of

Sacramento River to the water-deficient lands of the San Joaquin Valley. When it became known that there was enough water for both and that the design of the project contemplated only the exporting of surplus water, there was little difficulty in agreeing upon the terms of what is now Sec. 11460 of the water code. This is known as the Watershed Protection Act. It provides in simple language that in the operation of the Central Valley Project nothing shall be done that would deprive the watershed of origin of any water ultimately needed for local use therein.

Two sharp distinctions between this law and Sec. 10505 are immediately evident.

The first is that Sec. 11460 deals with the distribution of project water. Project water is that which is available only because of the existence and operation of the physical structures which comprise this man-made project.

The second point of difference is in the description of the geographical area for whose benefit water is reserved. For purposes of the Central Valley Project the potential conflict of interest lay between the watershed of the Sacramento River in its entirety and the service areas to the southward in the watershed of the San Joaquin River. Geographically, the question was that simple. Hence, it is not surprising to find the reservation being made in terms of the watershed of origin.

There has been considerable discussion about the two statutes making reservation in terms of different types of areas; one dealing in terms of counties, which may include several watersheds; the other dealing in terms of watersheds which may traverse several counties. The distinction was intentional. Each relates to a separate phase of the problem, both of which remain with us today.

Proposals to change or modify these laws concern, for the most part, the Watershed Protection Act. The reason is that the Feather River Project has been defined by the legislature as a unit of the Central Valley Project. This has the effect of making the Feather River Project subject to the provisions of the Watershed Protection Act.

The dissatisfaction with the Watershed Protection Act from the viewpoint of the water-deficient areas south of the Sacramento Delta can be stated very simply. They correctly feel that the effect of the Watershed Protection Act is to make project water delivered by the Feather River Project subject to recapture by the watershed of origin at any time in the future that it becomes needed. It is not sound business, they say, for the state to invest billions in a 500-mile distribution system which may some day be dried up as the result of the water being recaptured for use in the watershed of origin. The further investment of additional billions of both private and public funds to develop communities to be served by water from this project are not justifiable unless there is firm assurance that water is to be supplied to them on a permanent and continuous basis. I think that this is an entirely reasonable objection to the literal meaning of the present law. The most encouraging thing about the county-of-origin problem is that the objectives and desires of people in all parts of the state are not only reasonable, but they can be achieved.

State Planning

Today we are on the threshold of a new era in our water development. Heretofore water development has

been mostly local and, where large projects beyond the capability of a single local agency have been built, they have been on a regional or sectional basis. Illustrative of this are the Colorado River Development and the Central Valley Project, both financed by the federal government.

With our remarkable growth in population of the past 20 years—which is continuing—we are now compelled for the first time to embark upon the planning of project construction on a truly statewide basis. The Feather River Project alone will touch upon half the counties of the state and cover two-thirds of its length from north to south. It will export out of the Central Valley Basin almost 2,000,000 acre-ft of water which originates in that basin and will eventually be needed for use within it. Some day this water will have to be replaced with water originating in the North Coastal Basin, which has the greatest undeveloped surplus of the entire state.

In looking to the future, three facts seem to me to be controlling of our decisions.

The first is that we have enough water within California for our ultimate needs in supporting a population of 40,000,000 people and irrigating more than twice the presently developed acreage. Our only problem is one of distribution, and the engineers tell us that, given the time and the money, this can be solved.

The second thing to be noted is that the stream flow in Northern California is just as seasonal and as flashy as it is in the dry washes south of the Tehachapis. In Northern California 80 per cent of the total annual runoff occurs in the 5 months between December and May. The violence of these runoffs was tragically illustrated in 1955. This means that during the irrigation season from June through October, Northern California streams produce less than 20 per cent of their total runoff. The significance of this fact is much better understood in the north than it is in Southern California.

The third fact is that today the reservation of a water right as provided in Sec. 10505 is no longer sufficient to protect the interests of the north. When the County-of-Origin Law was passed, 25 years ago, there was still unappropriated water in Northern California streams during the summer months when it was needed. Protected by a reservation made under Sec. 10505, a water user in the north could go to a nearby stream in June or July, when he needed water, and find it available for the taking. This is no longer true. With the passing of the years, population growth, and increased usage, there is no longer unappropriated water in the Sacramento River Valley at the time of year when it is needed. Consequently, for the first time in its history the northern part of the state is just as dependent upon the construction of water storage projects for its future needs as any part of the state. Dams to store the December floods until they are needed in July are required to serve water users within the areas of origin as well as in the water-deficient areas south of the delta.

Let me illustrate the problem which confronts us in this way. Take, as an example, any watershed in Northern California, whether it be the Feather, the American, the Eel, or the Trinity rivers. As far as providing for local needs within the watershed, development can occur in three ways:

1. Dams can be built to conserve water and the water permanently exported under contract to other parts of the state, leaving none of the developed water for local use. This alternative would be, of course, an unjust

absurdity which no one seriously considers.

2. Projects can be built and water exported to serve the present needs of outside areas with provision for its being recaptured for local use within the watershed of origin as and when it becomes needed in the future. This is, in effect, what is provided by present law. I have already referred to the inadequacy of this alternative. To me, it is just as wrong to deprive Kern County of project water once supplied, as it would be to deprive Plumas County of water needed for local use by exporting it to other parts of the state.

3. The only remaining alternative now becomes evident. If the immediate needs of outside areas are to be permanently served by exporting water, future needs within the watershed of origin can only be met by the construction of additional water storage facilities when and as they are needed. The water is there, and only needs to be developed and conserved by storage dams to be available for beneficial use. However, it must be developed by project construction because of the highly seasonal nature of the stream flow.

Two other points may be noted, and the pattern of future developments will begin to emerge.

1. As long as a water user south of the Sacramento Delta receives the quality and quantity of water for which he contracts, it makes no difference to him whether that water originates in the watershed of the Feather, the American, the Eel, or the Trinity rivers. The converse is definitely not true. Residents of the Feather River watershed, for example, must find their source of supply within the valley in which they live, or do without.

2. Further, water users south of the delta are not concerned with the rate at which storage reservoirs are built in any particular watershed of origin. Since all surplus must necessarily move southward to and through the delta, it makes no difference in which watershed it is stored until the time of its release. On the other hand, this question of the rate of development of stored water within his own watershed is the very crux of the problem which confronts every water user in Northern California.

Solving the Problem

The foregoing considerations all play a part in formulating a solution to the so-called counties-of-origin problem. The objective, as I see it, is twofold: First, to devise a legally adequate form of assurance that the delivery of water from any state-owned project will be permanent. This means that once a given quantity of water is delivered to water-deficient parts of the state it cannot thereafter be diverted or recaptured for use in the area of origin. Second, this must be accomplished in a manner that will not deprive the areas of origin of any water which they may ultimately need for local use.

There seems to be fairly general agreement that the first objective can be achieved in a simple, straightforward manner. It involves the execution by the state of a firm and binding contract for the furnishing of water from state-owned projects. Many of these contracts will be for permanent service. Some of them will undoubtedly be for the future delivery of water; that is, deliveries which are to commence some time in the future. There may also be need to devise an option type of contract.

Lawyers feel that an amendment to the state constitution is needed properly to authorize such contracts and, more especially, to put them beyond

the reach of legislative modification after their execution. This is a technical point of constitutional law. The provision in the constitution forbidding the state to impair the obligation of any contract, does not apply to contracts between the state iself and its political subdivisions. Yet most of the water contracts which the state will make will be with cities, counties, irrigation districts, and water districts of many types. These are all political subdivisions and public agencies over which the legislature has plenary powers. For this reason, I believe that a constitutional amendment will be needed. There should be the same stability and permanence to a contract right to water from a state-owned project that there is in our present law of water rights.

The second objective (not depriving area of origin of any water it may ultimately need) seems to me to be equally attainable, although the detailed plan of solution is more complicated and, hence, more provocative.

It seems obvious that if only surplus water is to be exported from the areas of origin, but what is exported is exported on a permanent basis and not subject to recapture, there must be some determination of the quantity of this surplus. This assumption has been the starting point of all of the present discussions.

Unfortunately, none of us has a crystal ball in which to foresee the future. Consequently, any solution which involves a present determination of ultimate future use within the areas of origin presents definite problems. If you determine ultimate use now and permanently commit the surplus to export, in a practical sense you may have placed a limitation on the future use of water in the area of its origin. It would be shocking to suggest that, based upon present knowledge, we should place a ceiling for all time on the quantity of water which may—as a matter of constitutional law—be used within Los Angeles County. Yet some such *tentative* determination concerning an area of origin is needed, if we are to go forward with any program of water development under present day conditions.

The key to this situation may be in the words "tentative determination," as I have just used them. The present determination of ultimate local use is needed only for the purpose of planning today's project and to provide an intelligent basis for permanent export contracts. However, this does not mean that it must also limit the future use of water within the area of origin. Certainly, it does not mean that such determinations made today should act as a limitation on the power and intention of the state to follow through with a program of financing and building projects which are beyond the capabilities of local agencies, as they are shown to be economically feasible and sound in their engineering concept.

Very frankly, and again expressing my own opinion, I think it unlikely that an acceptable solution to the county-of-origin problem can be found which does not involve a sustained program of water development, that is to say, project construction. On the other hand, if the state will assume responsibility for the financing or construction of sound projects which local agencies cannot build and which the federal government will not build, then the problem is reduced to one of mechanics.

We are fortunate, indeed, where the topography of the state is concerned. The very mountains and rivers which create our problem also provide the key to its solution. As more and more storage reservoirs are built within the

various watersheds of the north, the exchange of developed water and the substitution of the surplus waters of one watershed for those of another becomes entirely feasible. This is a matter of engineering and the sound operation of an overall water storage system comprising many different units or projects. We know the water is there and only needs development. The question is one of money, and assurance that, within the limits of financial feasibility, projects will be financed or built in such sequence and at such locations as to prevent any area of origin from being deprived of developed water for which it is prepared to pay the necessary and fair charges.

In what I have said there is a large element of give and take required of people throughout the entire state. North of the delta it should be recognized that the heyday of free water available from the run of the stream is a thing of the past. Water for the future must be developed and stored in projects. Projects cost money, no matter who builds them, and the delivery of water necessarily must be paid for. It should also be recognized that water users once supplied with water must continue to receive it regardless of where they live or where the water is being used.

South of the delta it should be recognized that the Feather River Project involves the expenditure of a cold billion dollars of state funds for the construction of project works from which the areas north of the delta can never benefit in any way, shape or form. They should recognize that the quantity of surplus water available for their use cannot be determined with certainty and for all time. The areas of deficiency cannot foresee their own future needs and it is unfair for them to expect the areas of origin to do what they cannot do themselves. As I have said, once water is exported from the areas of origin, service must be permanent. However, in all fairness to the areas of origin, such permanent service is only possible if there is assurance that, as the need for water develops within the area of origin, feasible and sound projects will be built to take care of such needs.

On this analysis I think it is clear that a detailed plan for the solution of the counties of origin problem involves nothing less than the outline of a firm and long-range program of state participation in project construction and financing. It also involves the embodiment of this outline to some degree in the constitution of the state. Here in California we have long used our state constitution for the purpose of establishing long-range policies which place certain definite obligations upon the legislature to carry them into effect. I suggest that the needs of our great and growing state may well require that type of approach to insure adequate and equitable water development.

Summary—*Samuel B. Morris*

The ten papers presented above clearly indicate that much progress has already been made in developing the California Water Plan. Many years of study and $8,000,000 spent in making surveys have crystallized the formation of the Feather River Project as the first unit of the California Water Plan. In spite of the favorable reception, the thoroughness of study, and the completeness of the plans, the project cannot come into being with-

out a great deal of legislation by the next session of the California legislature. Legislation should include the necessary constitutional amendment, appropriation of funds, and authorizing of a bond issue to provide the added funds required to complete the $1,600,000 Feather River Project.

As an expression of California Section policy, the following resolution was adopted:

Whereas the Legislature of the State of California, recognizing the shortages and unequal distribution of water supply of the state, in 1947 authorized studies to be made which have culminated in the California Water Plan, and

Whereas the legislature in 1956 created the Department of Water Resources to coordinate water planning in the state and to carry out the California Plan, and

Whereas the time required for planning, construction and completion of the first major element of the plan may take 15 to 25 years, and

Whereas the need of certain elements of the plan is extremely urgent in some areas, and

Whereas some projects will soon be moving from the planning stage to direct implementation by the legislature, and

Whereas many elements of the plan will require complete cooperation of federal, state, local, and private agencies, and

Whereas a review of the State Water Plan with its many facets and complications was presented to the California Section of the AWWA at its meeting in San Diego on Oct. 25, 1956,

It is hereby agreed that the California Section of the AWWA, assembled in San Diego on Oct. 26, 1956, adopt the following policy to guide its members:

1. The section endorses the principles and purposes of the State Water Plan in outlining the comprehensive development of the water resources of the state with the understanding that plans for future development will be subject to continuing frequent review.

2. The section concurs in the principle of cooperation of federal, state, local, and private agencies in development of water resources.

3. The section recognizes the immediate critical water needs of certain areas of the state, especially the South San Francisco Bay area, the westerly side of the San Joaquin Valley, San Diego County, and certain other areas south of the Tehachapi mountains. Owing to time consumed in building, the need to press the rapid construction of the Feather River Project is equally necessary for the entire south coastal plain in order to provide water requirements in 12–15 years.

4. Although the section is cognizant of the complexities of meeting the water needs of many communities under varying conditions, the section adheres to the principle that all areas should receive benefits in proportion to their needs and to their economic development.

5. The section is aware that the underground basins of California are now overdrawn by 5,000,000 acre–ft per year and that the first unit of the plan (The Feather River Project) will produce only 4,000,000 acre–ft per year; consequently the section emphasizes that there is need for the immediate development of additional units of the plan.

6. Recognizing that some projects of the California Water Plan are moving rapidly from the planning stage to direct implementation by the legislature, the section maintains that it is the duty of the officers and all members of the section to acquaint themselves and their communities with the plan and take the responsibility to keep their legislators informed of their own local plans and needs.

7. The section believes that each area should develop its own comprehensive plan and coordinate such development with the State Water Plan.

8. The section endorses the principle that the State Water Plan should supplement and not compete with the plans of

local areas or with regional projects that are already developed.

The resolution of the California Section Meeting of the AWWA is not the only such proposal concerning the California Water Plan to be presented to the 1957 state legislature.

The Southern California Water Coordinating Conference is composed of representatives of about 40 water-serving corporations, both public and private, called together by the Los Angeles Chamber of Commerce and the Southern California Conservation Association. Their purpose was to correlate ideas of the various participating organizations with the hope that a program might be developed which would enable all interests in the southern part of the state to work in close harmony with other groups throughout California in expediting the construction of the Feather River Project as the first unit of the California Water Plan.

At its first meeting on May 29 1956, the conference named a fourteen-man executive committee with William S. Rosecrans and the author as co-chairmen. The committee has held many meetings with other organizations of local and statewide interest. The conference has now approved the ninth draft of a policy statement prepared by its executive committee which was transmitted to the state legislature convening in January 1957.

The following is the Basic Principle for Statewide Water Development which was adopted by the Southern California Water Coordinating Conference:

Many of California's water problems have been created or aggravated by the addition of more than 5,000,000 people in the past decade. Further population increases of great magnitude appear to be inevitable, as well as ever increasing demands for agricultural products. The future growth and well being of many areas of our state are in jeopardy by reason of floods or inadequacy of available water supply, so that the proper and satisfactory solution of California's water problems is a matter of both statewide and local responsibility. Because of these compelling facts, the Southern California Water Coordinating Conference proposes the following principles to serve as guide lines for the development of the Feather River Project and other units of the California Water Plan.

State Water Policy

California, in embarking upon a program of financing, constructing, and operating water projects, should adopt a comprehensive water policy. Adequate water supply and flood control for various sections of California are no longer matters of only local concern, but now have become a statewide concern. The legitimate needs of each area must be considered against a background of the needs of all other areas and of statewide interest and economy. We are assured that there is enough water, including California's rights to Colorado River water, to meet all future needs throughout the state.

The state of California now has the opportunity, in accord with these premises, to develop and institute a thoughtful and wise policy which may be used for the Feather River Project and, also, be applicable for development of other units of the California Water Plan.

Just as local agencies should own and operate their works, so should the state of California own and operate its statewide water projects, and any appropriate federal assistance should be on a cooperative basis.

Local users should construct and operate their own distribution facilities.

Consideration should be given to the relationships which will exist between

the Feather River Project and subsequent projects in the preservation of the Delta Pool with respect to quality and quantity, and the responsibilities of the state as well as those who may draw water from that source.

The problem of water for future needs for areas of origin and areas of deficiency must be met and solved with equity for all. The state must assume enforceable responsibility for the reservation of sufficient water to provide full protection to areas of origin and responsibility for full contract deliveries to areas of deficiency.

All state water projects should be reimbursed as set forth herein.

Where the public interest will be served, local agencies should be enabled to receive state financial assistance for the construction of local projects which conform and contribute to the California Water Plan. This assistance should be in accord with the principles set forth herein.

Time and Need

With respect to time and need, all areas of California are concerned with an immediate start on the Feather River Project and expediting its completion.

The great damage and loss of life on the flood plain of the Feather River below Oroville in the winter of 1955–56 demonstrates the need for immediate construction of the Oroville Dam.

The rapidly receding ground waters and high pump lifts in the westerly and southerly portions of the San Joaquin Valley in Fresno, Kings, and Kern counties, and the rapidly receding ground waters in the south San Francisco Bay area affecting areas of domestic, industrial and irrigation use in these counties require prompt construction of pumping plants, canals, and the San Luis Reservoir to avoid severe losses. Certain areas south of the Tehachapis need water now. The demand for an intensive construction program is therefore pressing, not only for the northern areas but also for the areas south of the Tehachapis, because this latter service area lies at the exteme southern end of the project and aqueduct system.

Water Rights

1. Solution of the area-of-origin problem contemplates the acceptance of the policy and philosophy in connection with state or federal projects that watersheds where the water originates be legally and fully protected with enough water for their reasonable, ultimate beneficial needs.

2. It is equally important, with particular reference to the Feather River Project, that the areas of deficiency to which the surplus water is to be exported, be legally and fully protected for the amount of water for which they will have contracted for delivery by the state. This protection is necessary to enable the areas of deficiency to ascertain whether or not it is feasible and economically prudent for them to join in financing the construction of works of such magnitude as the Feather River Project and to build their future economy on such water supply.

3. In order to provide the strongest legal protection and stability, both for the areas of origin and for the areas of deficiency, it is important that the method for these determinations be fixed by constitutional amendment. It should be limited to unappropriated waters of the state and should not in any sense invade existing water rights.

4. The proposed amendment should provide that determination be made by the legislature as this body represents the respective viewpoints of all sections of the state. To guide the legislature and to secure as objective and engineeringly scientific approach as possible the facilities of the Department of Water Resources, the State Water Board and the State Water Rights Board should be used to the fullest extent possible in processing or recommending such determinations.

Engineering

Projects under the California Water Plan, and the Feather River Project as the first unit thereof, should be based upon a finding of engineering and economic feasibility before such projects are authorized for construction by the state. It is obvious that engineering must not alone consider the greatest economy in construction and operation but must also consider water quality. Assurance must be had that those areas to which water may be made available can afford to pay the costs properly allocated for construction, maintenance, and operation. Unnecessary duplication of facilities should be avoided.

Feather River Project:

1. Substantial progress has been made by the state of California in engineering of the Feather River Project. Progress should be made as rapidly as possible to complete determinations of routes and areas to be served. Final commitment regarding the entire project should be made as soon as the legal rights to the use of water made available by the project are established pursuant to the constitional amendment and the engineering and economic studies now being conducted by the state affecting such matters are completed and their adequacy and application sufficiently analyzed by the interested areas.

2. Notwithstanding the necessary delay in providing for the financing of the project in its entirety, highway and railroad relocations in the Oroville area should be commenced at once; simultaneous acquisition of the Oroville and San Luis dam and reservoir sites should be accomplished by the state without further delay in line with the intent expressed by the state legislature; and as much money as necessary should be appropriated for these purposes and for further engineering studies along the entire route of the project to speed final determinations.

3. The routes south of Devil's Den and their elevations will depend upon surveys, estimates, and comprehensive economic studies.

Financial Policy

The following policies should apply in the financing of the Feather River Project and also to other projects of the California Water Plan:

Sources of Funds:

California as a state should assume the overall responsibility for financing the Feather River Project. In order that there be assurance of adequate financing, in addition to funds then authorized, general obligation bonds in an amount sufficient to complete the entire project should be authorized as early as possible, even though this might mean that more bonds are authorized than are sold because of receipt of funds from other sources as hereinafter proposed. While the bonds to be issued will be general obligation bonds of the state, they should be supported by contracts of reimbursement to be made with each water or power user agency.

1. The state should appropriate from the general fund monies for acquisition of reservoir and dam sites, rights of way, relocation of highways and utilities, and for improvements removed or damaged by construction of the project.

2. Funds properly allocable for the construction of improvements for recreational projects of statewide interest should be provided from the state's tidelands oil revenues and investment fund.

3. Funds of the state, such as the "rainy day" fund and sums derived from the state's tideland oil revenues and investment funds thereof, may properly be made available by the legislature as underwriting for the construction of the project.

4. The federal government should be requested to supply funds in line with present or future federal policies, including allocations to flood control, fish and

wildlife, recreational values of national interest, and navigation.

5. Where areas express a desire for irrigation funds under reclamation law, the federal government may be requested to supply funds properly allocable for irrigation in connection with a state project, provided no handicaps are placed on state ownership and operation.

Allocation of Costs:

The state should adopt a policy for determining benefits and costs which, based on recognized methods, will result in reasonable and fair allocations.

Repayment:

1. State monies for acquisition of reservoir and dam sites, rights-of-way, relocation of utilities and highways, and for improvements removed or damaged by construction of the project should be nonreimbursable.

2. State funds for recreational improvements of statewide interest should be nonreimbursable.

3. Federal funds for flood control, fish and wildlife protection, recreational improvements of nationwide interest, navigation and other items in line with established policy should be nonreimbursable.

4. Federal funds for irrigation should be reimbursable, in accordance with federal policies then prevailing.

5. All other funds, including those for power and for domestic and industrial water supply and irrigation should be reimbursable with interest.

6. The revenues of the project should be pledged to operation, maintenance, and the payment of debt service.

7. The state should enter into contracts with water distributing agencies before water is delivered. The contract should cover repayment of the costs allocated to that particular agency, including debt service. The contract should include a commitment by the agency to provide the works required to make its connection to the Feather River Project. Each such agency should provide distribution works for delivery to its own customers.

8. An agency may satisfy its contractual obligation to the state by taxes levied upon the property within the agency by the application of any revenue of the agency, or by any other sources of income available to the agency.

9. The state should have the power to enjoin any person from taking the Feather River Project water without first entering into a contract with the state.

General

The successful development of California's water resources for the benefit of all sections of the state will involve great complexities and the expenditure of vast sums. Its consummation will depend largely on general public support of a program based on good engineering and sound principles of economics and finance.

The foregoing set of principles is offered by the Southern California Water Coordinating Conference for application to the Feather River Project, but it is also hoped that they may serve as a contribution to the equitable development of the California Water Plan.

These principles have been considered by the conference for many months and have been widely discussed with leaders from many parts of California. While unanimously approved by the conference, it is not claimed that they represent the complete thinking of the individual members of the conference. Rather, they represent the balancing of many ideas presented into a statement which we believe to be fair, equitable, and sound, with some give and take on the part of all who participated. The members of the conference at all times have acted in their individual capacities without involving any approval implied or expressed by their agencies or organizations.

Rebuilding a Small Public Water System

J. Wallace Grant

A paper presented on Oct. 31, 1956, at the West Virginia Section Meeting, Bluefield, W.Va., by J. Wallace Grant, Chemist, West Virginia Water Service Co., Charleston, W.Va.

BURNSVILLE is a small, pleasant, rural community in Braxton County, near the geographical center of West Virginia. The population of the Town of Burnsville was 731 in the 1950 census. The community is incorporated under the laws of West Virginia, with a mayor-and-council form of government.

At the time the West Virginia Water Service Company acquired the Burnsville public water system in August 1947, the town was supplied with Little Kanawha River water, unfiltered and treated only by chlorination. Naturally, every time the Little Kanawha was turbid the Burnsville water supply was also turbid. This water supply was classed by the West Virginia Department of Health as dangerous.

At the time the Burnsville system was purchased there were 126 water accounts. A small increase in the number of consumers has been noted from time to time until at present there are 161 consumers; definitely a small public water system.

The Burnsville water system in 1947 consisted of a pumping station at the river, a chlorinator, a wood-stave tank for elevated storage of 60,000-gal capacity and 15,043 ft of main, all of which were of galvanized iron. Of the main, 500 ft was 3 in., 9,286 ft was 2 in., and 4,252 ft was ½ in. The remainder ranged from ¾- to -¼-in. in size. The Burnsville Water Company, a subsidiary of the West Virginia Water Service Company, owned and operated the Burnsville water system from August 1947 to Dec. 1954, when the company was dissolved and ownership transferred to the parent company.

The new owners found that excessive leakage was the most pressing problem. Only 30 per cent of the water was usually accounted for. Many leaks were repaired in the 1- and 2-in. galvanized lines, until it had to be admitted that most of these mains were beyond permanent repairs, so that a replacement program was undertaken.

The location of the river pumping station subjected the plant to floods of the Little Kanawha River, thus halting the use of the pumps.

As the Burnsville system was consistently losing money, it became necessary to apply for an increase in water rates. The increase was granted by the West Virginia Public Service Commision, effective Jan. 16, 1948.

Filter Plant

Having the rate increase approval, the next step in the reorganization of the water system was to provide the town with a safe, filtered water supply. A plant site safely above the highest recorded flood level was pur-

chased, and work started on building a small, modern filter plant designed to keep costs as low as possible.

A review of needs of the community indicated that a capacity of 100 gpm would be desirable. In choosing the optimum size of the plant, two alternatives presented themselves—a large plant, operating a few hours a day with one supervisor, or a smaller unit, working for longer periods of time and thus calling for a two-man staff. As the salary of an extra employee was a major expense, the larger unit was deemed more economical. A low-lift, vertical turbine pump of 100-gpm capacity was installed at the river with the motor on a tower above flood level. This pump lifts raw water to the filter plant which stands on higher ground about 70 yd from the river.

A 100-barrel oil storage tank was adapted as a filter shell. An underdrain system and wash troughs were installed, as well as gravel, sand, and the necessary piping and valves to make a gravity filter of 100-gpm capacity.

The settling basin was constructed in a new wood-stave tank 11 ft high and 20 ft in diameter. Over and under mixing apparatus was built into the circumference of the basin, and a steel spiral baffling to the effluent at the center was also installed. A vertical, slotted, stilling baffle was placed across the spiral baffle at a point where flocculation was complete. The basin has a 10-hr detention period.

A horizontal 100-gpm centrifugal pump with a 250-ft head was purchased new for the high-lift. Suction for this pump was taken directly from the two clear wells constructed of steel tanks of 4,000-gal capacity. A filter wash water pump was purchased new and installed to take suction from the two clear wells.

On recommendation of the Sanitary Engineering Division of the West Virginia Health Department, solution feeders were selected over dry feeders. The small amount of flow through the plant made this logical. A twin unit was purchased to feed alum to the raw water and hydrated lime slurry to the clear well for pH adjustment. Operating experience, however, indicated the need for lime to assist in coagulating the raw water, with the result that a single unit feeder of the same type was purchased for this purpose.

On one side of the plant a neat laboratory bench was built and all necessary equipment purchased to make a daily routine chemical analysis of the water. Regular bacterial samples are collected for examination at the Weston laboratory of the West Virginia Water Service Company.

The plant, located near the center of town, doubles as the business office for the system. The building is constructed of cinder blocks, neatly painted and surrounded by attractive grounds to fit into the residential district. The low-lift pump, sedimentation basin, and one clear well are not housed.

New Storage Tank

The rebuilding of the Burnsville water system continued with the replacement of the old wood-stave tank for elevated storage, with a 100,000-gal steel standpipe. This required purchase of a suitable lot and laying of 1,600 ft of 6-in. transite main from the filter plant to the new tank. There was a dramatic drop in pumpage when the new tank was placed in service September 1954. September pumpage was 67 per cent below that of January

of the same year, when the leakage of the old tank was eliminated.

It was known that the town council of Burnsville was interested in fire protection for the community. The community has a highly-rated volunteer fire department which formerly used a tank truck for fire fighting. During the planning of the system, the possibility of adding fire protection at some future date was kept in mind, and the system was accordingly designed. An agreement was made with the council to provide nine fire hydrants at various points in the city. This service required laying 6-in. mains to the various hydrants; the town agreed to dig and backfill the ditches, and the West Virginia Water Service undertook the laying of mains and installation of hydrants. This job is almost complete so that Burnsville has a water system which provides both filtered water and fire protection.

After completing the installation of the new elevated storage tank and filter plant, it was found that the Burnsville system was again losing money so that another rate increase was requested of the West Virginia Public Service Commission. The commission granted higher rates which became effective Dec. 30, 1955.

About the only portions of the old water system which were salvaged and are still in use are the chlorinator and some small mains. Until the end of September 1956, the total main footage had increased from 15,043 ft to 18,748 ft. This increase included 2,297 ft of 6-in. transite, and 172 ft of 4-in. transite. The amount of ½-in. lines had been reduced to one-half the original footage.

Total cost of rebuilding this small water system, exclusive of the cost of providing fire protection, was about $43,000.

Quality of Water

Water now served consumers at Burnsville is excellent. The Little Kanawha River at Burnsville is classed as "A" quality by the West Virginia Public Service Commission. Taste and odor problems are almost unknown. For one brief period a small amount of activated carbon was used to solve an odor problem.

The contrast between the sparkling, filtered water and that to which residents were accustomed was quite striking, as the unfiltered water was often quite turbid and was always unfit for drinking water. Many residents stopped in to thank the superintendent after the change to filtered water was made.

Burnsville finished water is a soft water with low alkalinity. Hardness averages 40 ppm, and total alkalinity 16 ppm, both expressed as calcium carbonate. Chlorine is applied to the filtered water with the residual chlorine averaging 1.2 ppm. About 70 finished water bacterial samples a year are collected and all samples collected in 1954, 1955, and 1956 have been found to be safe.

Preparing for a Rate Increase

Panel Discussion

A panel discussion presented on Nov. 1, 1956, at the West Virginia Section Meeting, Bluefield, W.Va.

Utility Viewpoint—*Cecil C. Macdonald*

A paper presented by Cecil C. Macdonald, Vice-Pres. & Treas., West Virginia Water Service Co., Charleston, W.Va.

INFLATION stemming from World War II has forced many utilities to increase their rates. The tremendous expansion of the nation's economy since then has compelled utilities to enlarge plant facilities and increase distribution systems during a period when construction costs were rising sharply. *The Engineering News-Record Construction Cost Index* was 308 at the end of 1945. Today it is approximately 705, an increase of 229 per cent. It is not necessary to mention actual rising prices of pipe, copper tubing, and other materials as most water works operators have first-hand experience of this. The cost of 6-in. and larger cast-iron pipe has increased more than 200 per cent in the past 20 years. Operating expenses, taxes, and depreciation charges have also greatly increased. The West Virginia Water Service Company retained approximately 40 per cent of its revenue dollar for debt and equity charges 20 years ago. This declined gradually to a low of 25 per cent in 1951, but the trend has now been reversed. The same is true of other utilities. The return from rates has diminished to a point that has forced management to seek relief through rate increases. The rates of the Charleston, W.Va. system, fixed in 1920, remained unchanged until 1951. For many years the added revenue from growth in the Kanawha Valley helped to offset in part the corroding effect of inflation on the rate of return from the system. In 1950 it became necessary to petition for a rate increase.

Many utilities can weather a brief span of inflation, and management usually prefers using reserves to carry the company through these short periods rather than disturb the rate structure. An extended inflation, such as the one in 1946, forces utility management to seek higher rates to provide income and capital needed for expansion.

The adequacy of rates should be checked periodically. The timing of rate increases depends on the trend of the rate of return. Each utility must fix a point beyond which the efficient operation and expansion of the system are jeopardized. Once this point is reached, immediate action must be taken to start the prosecution of the rate increase. Rate increases are not retroactive and any delay in petitioning for higher rates causes a permanent reduction in income.

Preparing for a Rate Case

A utility anticipating a rate case should put its house in order by [1] having the most efficient operations possible; [2] resolving all service complaints (good public relations pay dividends); [3] completing major construction jobs and having them in service prior to the end of the test period which will be the date for establishing the rate base; [4] retiring from the books all property which has been replaced or is no longer used or useful; and [5] informing customers and public officials of the utility's need for higher rates (this practice lessens customer resistance and opposition).

Customers' accounts must be blocked to secure the necessary data for compiling new rate schedules. Blocking is accomplished by analyzing accounts by consumption steps for various periods of time depending upon the size of the system. The accounts of a small plant can be blocked for 12 months with little time and expense. In the case of the Charleston system, analysis for 2 months was made of what was considered to be average consumption months.

A large map of the territory served is a valuable aid in outlining and describing the utility system and answering questions about it at the hearing before the Public Service Commission. Such a map can show the location and size of mains, location of hydrants, pump stations, standpipes, tanks, and sources of supply. It can also be filed as an exhibit with the commission.

Informing Customers

The primary means of informing customers and public officials of the Charleston utility's need for higher rates was a pamphlet entitled "Information in Connection With Proposed Water Rate Increase." The pamphlet was addressed to the water customers of the city and began by briefly setting forth the salient facts of the company's case supported by statistics. Investments in utility plant, number of customers, and miles of main were shown for the end of each calendar year for a 5-year period. In addition, figures for gross revenue, operating expenses, net earnings, and decline in the ratio of net earnings to utility plant investment were given. The bulk of the pamphlet featured ten schedules which dealt with the following topics:

1. A summary by account classification of the reproduction cost new, less depreciation value of the utility system at the end of the established test period (although the West Virginia Public Service Commission fixes rates on the basis of depreciated original cost of utility plant, this schedule was included to show the approximate present day value of the utility plant. The schedule can be compiled by trending original cost figures or trending an earlier reproduction cost appraisal and subsequent additions)
2. A summary by account classification of the original cost of utility plant at the end of the test period
3. A statement of utility operating income for a 2-year period, including the test year, showing details of operating revenues, operating and maintenance expenses, taxes and depreciation
4. A condensed statement of utility operating income for a 5-year period
5. The rate of return realized on the company's depreciated investment in utility plant during the test year (this schedule is included in the pamphlet if the company's investment is different from the original cost of utility plant)

6. The rate of return during the test year on the depreciated original cost rate base at the end of the test period
7. The amount of additional revenue required to give the utility a fair return (this schedule includes the annualized cost of added operating expenses incurred during the test year)
8. The annualization of revenue from new customers added during test period
9. The higher rates proposed
10. A comparison of the proposed rates with the present rates and the increase.

The pamphlet just described was delivered to each of the company's customers and public officials prior to filing the new rates with the Public Service Commission. At the hearing before the commission, the pamphlet was introduced as evidence and used to inform the commission of the salient facts in the case. No other schedules were filed by the company. Naturally, if the commission requests further information, it is compiled and filed to support the company's position. The pamphlet thus serves two purposes: First, as the medium to inform the public of the company's need for higher rates and, second, as an exhibit in the presentation of the case to the public service commission.

In the Charleston rate case, pamphlets were not distributed to the customers in the Kanawha Valley. Public officials in the municipalities and towns served, however, were given a booklet similar to the one just described.

Other Information

Additional information which is valuable and can be filed with the commission includes such things as a schedule showing the deficiency in the rate of return for periods prior to the rate case, and a schedule of the utility's investment in property during the test period which has not produced revenue. The commission should include these investments in the rate base, and not average them as are other plant additions during the test period. Other information given to the commission might include explanations of major fluctuations in operating expenses, and principal utility plant additions and improvements since present rates were made effective.

Presentation of Case

After all data have been prepared for the presentation of the utility's case, the new rates are filed with the public service commission to become effective in approximately 30 days from date of filing. In all probability the commission will then order an investigation of the propriety and reasonableness of the proposed rates, at the time suspending the effective date 4 months. A date for the first hearing at which the utility may present its evidence in support of the proposed increased rates is fixed. It is necessary to post a copy of the new rates, and the time and place of the hearing at each of the utility's offices and collection agencies. A copy of the commission's order suspending the effective date of the new rates must be published once each week for 4 consecutive weeks in a local newspaper.

Prior to the date of the first hearing, it is advisable to have a conference of utility officials, attorneys and witnesses to review the evidence, and brief the witnesses. A well-prepared rate case and competent witnesses make a good impression on the regulatory body. A good presentation of

evidence at the first hearing may obviate further hearings.

Subsequent to the hearing the commission auditors and engineers are assigned to the case. Utility accounts and records are thoroughly audited. Cooperation with the commission personnel is essential since they must prepare evidence for a fair ruling. A utility which operates efficiently, meets service demands, and maintains records and accounts as prescribed by the commission, will receive just consideration from the commission. Certain regulatory rulings and practices must nevertheless be opposed. Utilities can no longer acquiesce to rulings which average depreciated original cost rate bases and which grant too little depreciation allowance in the face of current replacement costs. Utilities must also fight for greater return allowances to offset the diminishing value of the dollar to holders of equity securities.

Anticipating, preparing, and prosecutting a rate case requires time, talent, and tact, but a case justified and grounded on irrefutable facts and figures brings a harvest of needed dollars.

PSC Viewpoint—*Homer W. Hanna Jr.*

A paper presented by Homer W. Hanna Jr., Chairman, Public Service Commission of West Virginia, Charleston, W.Va.

THE jurisdiction of the Public Service Commission of West Virginia is granted by the legislature in Chapter 24 of the Code of the State of West Virginia in the following terms:

> The jurisdiction of the Commission shall extend to all public utilities in this state, and shall include any utility engaged in any of the following public services: . . . supplying water, gas or electricity, by municipalities or others; sewer systems servicing 25 or more persons or firms other than the owner of the sewer system. . . .
>
> The Commission may establish a system of accounts to be kept by public utilities, or classify public utilities and establish a system of accounts for each class, and prescribe the manner in which such accounts shall be kept. It may also, in its discretion, prescribe the forms of accounts, records, and memoranda to be kept by such public utilities. . . .

Classes of Utilities

The commission, in prescribing a uniform system of accounts for the utilities, subdivides them into four classes: Class A includes utilities with annual water operating revenues in excess of $250,000; Class B, utilities with annual water operating revenues of more than $100,000 but less than $250,000; Class C, those with annual water operating revenues of more than $25,000 but not more than $100,000; and Class D, those with annual water operating revenues of less than $25,000. Classes C and D were established as effective Jan. 1, 1955, for privately owned water utiiities, and Jul. 1, 1955, for those municipally owned. The class to which any utility belongs is determined by the average of its annual water operating revenues for 3 years next preceding the current year.

Original Cost

It is noted in the uniform system of accounts that utility plant is to be recorded on the books of the water utility at original cost, which means the actual cost of such property to the person first devoting it to public serv-

ice. It follows that the commission considers the original cost of the utility plant in establishing utility rates, and is very much concerned about the price paid by municipalities in the acquisition of privately owned water systems. The purchase price is based generally on reproduction cost, new, less observed depreciation. This means, in most instances, that the cost of the water system will be more than the original cost to the first person devoting it to public service. The amount of return that may be included in the cost of service is based on original cost to the person first devoting the property to public service. If the price paid by the municipality is far in excess of the net original cost of the plant, the commission, on the basis of prior decisions, cannot approve rates that would be necessary to pay the annual debt service requirement. It is suggested that municipalities should apply to the commission for consent and approval of the acquisition of water utilities before any final agreement is signed with the bonding companies. When this procedure is followed, the commission's staff has an opportunity to investigate the reasonableness of the transaction and the proposed rates. This tends to avoid laying any hardship upon the water customers of the municipal water department.

Bookkeeping

It is important for the municipality to keep the water department's books and records in accordance with the system prescribed. It is a common practice of many municipalities, however, to keep books on a cash receipts and disbursements basis, and, in many instances, the municipalities do not maintain general ledgers. The record of cash receipts and disbursements are sufficient for the tax department but will not meet the requirements of the Public Service Commission. Without the proper accounting records, the water department cannot furnish the desired information for the annual report to the commission or furnish required evidence in support of a rate increase.

Rate Increases

The question has been raised as to when a publicly owned water utility should seek a rate increase. First consideration must be given to the question of what costs should be included for the determination of fair and reasonable rates. Municipal water rates are generally said to be fair and just if they produce revenues sufficient to pay operating expenses, provide adequate reserves for depreciation, pay the current interest and principal on the outstanding water revenue bonds, and provide a reasonable amount for working capital.

If the municipal water department rates do not produce revenues sufficient to cover these costs of rendering service, an application should be filed asking for an adjustment of rates.

The required procedure to be followed in the application for an increase in rates is explained by the commission as follows:

> A public utility desiring to modify, change, cancel, or annul any of its rates, fares, classifications, charges, or rules and regulations, may file with the commission its application therefor, together with four copies of the same, in the form prescribed by the commission for that purpose. Such application shall set forth (1) the rates, charges, rules and regulations in effect, (2) the proposed rates, charges, rules and regulations, (3) if increase or reduction in rates, estimated annual effect on revenue, and (4) the reason for the proposed change. The

applicant shall give such notice of the filing of its application and of the hearing thereon as may be directed by the commission.

The burden of proof to show that the proposed rate, or the proposed change in rate, fare, classification, charge, or rule is just and reasonable shall be upon the public utility making application for such change.

After receipt of the application, a date is set for the hearing and the utility notified of the necessary procedure by the secretary of the commission.

Although there is no rule governing the information to be furnished supporting an application to change rates, the applicant is expected to furnish the following information pertaining to the test year:

1. Comparative balance sheet
2. Detailed income statement, including per books adjusted for revenues at proposed rates, wages at current level, and elimination of nonrecurring items
3. Average investment, including original cost of utility plant, reserve for depreciation, contributions in aid of construction, and working capital
4. Operating revenues by classes of customers at present and proposed rates
5. Customers' bill analysis, either for a representative period or for the test year
6. All facts relating to bond issues, including data on amount of issue, interest rate (and date due), amount of coverage, and a statement showing the proposed amortization program.

Although it is the responsibilty of the utility to present proof that a change of rates is necessary, the commission answers any legal or accounting problems that may arise in the preparation of the evidence.

Causes of Delay

The commission has been criticized for delays in regulatory proceedings, but these delays result from the lack of proper information supporting the rate applications. The commission must base its conclusion on facts, and when these facts are not presented, the staff of the commission must make the necessary investigation to obtain them. Hence, where books and records have not been kept in accordance with the prescribed uniform system of accounts, compilation of the necessary statistical information becomes a time-consuming job. The regulatory delays are eliminated when municipalities follow the commission's uniform system and present the supporting information (as previously outlined) together with their applications for a change in rates.

Legal Aspects—*Ben K. Baer*

A paper presented by Ben K. Baer, Attorney, McClintic, James, Wise & Dadisman, Charleston, W.Va.

Rate making has become an exceedingly complicated process. Not only have customers greatly increased their use of utility services, necessitating large amounts of capital outlays and resulting rate cases, but the very process of making rates has developed into a formidable mass of accounting and engineering principles, all of which must be considered and adapted to the ever changing financial position of the company and to general economic con-

ditions. Each rate case is unique because of variations in plant, sales, financial, and operational problems. Rate making for water companies, then, is no longer the simple process of a decade ago. The job of preparation and presentation must be shared by all members of the management team if a sound rate structure is to be maintained. Proper strategy and techniques in rate making require careful planning by both the management team and its attorneys.

Rate-making Procedures

The decision to bring a rate case is the responsibility of management, but, once this decision has been made, it is the duty of company counsel to assume conduct of the case. Alternative rate-making procedures are available in West Virginia: rate cases may be initiated either by the filing of a formal petition under the rules of the Public Service Commission or by the filing of a new rate schedule as provided by the West Virginia Code. Under either procedure, statutory requirements for notice to the public must be complied with and are generally specified in the commission's order setting the case for hearing. Differences in timing and results may be anticipated under each procedure and must be evaluated.

To proceed by way of petition, the company files a formal petition pursuant to the rules of the commission stating that present rates are inadequate and requesting an increase to afford a fair rate of return. The commission will set the matter for a hearing pursuant to its rules, and new rates can not be put into effect until the final order of the commission following the hearing. Although the company may thereafter petition for, and will sometimes be granted, interim rates (conditioned upon the filing of a bond), the commission is generally reluctant to authorize interim relief. When proceeding by petition, the company has little control over the length of time which elapses before the final rate order of the commission is entered—save for the statutory requirement that a decision must be rendered within 3 months following the completion of the hearing.

The procedure for changing rates by statutory filing differs in that in this process the company gives notice that it intends to put into effect a specific new tariff at a given time. The West Virginia Code provides that no rate or tariff may be changed except after 30 days notice to the commission, and, during this 30-day period, the commission may suspend the operation of the prospective tariff for a period of 120 days beyond the time when such tariff would otherwise go into effect. Should the commission not enter a rate order during the 120-day suspension period, the company may, at the expiration thereof, put the new rate schedule into effect. In such a case, the commission may require a bond to insure the refund of any excess collections if the rates put into effect are subsequently determined to be higher than those finally fixed by the commission.

Apart from these differences, the actual conduct of the rate case will be the same under either form of proceeding. Once the formalities of notice have been complied with and the case set for hearings, conferences with the commission and its staff may be requested and should be held whenever feasible. The company bears the burden of proof of its cost of service throughout the proceeding.

Once the final order of the commission has been entered, the company has

10 days under the commission rules to petition for rehearing and, thereafter, may petition the West Virginia Supreme Court of Appeals to review the case. The probability of obtaining court review, however, is speculative: Until the Court agreed to hear the appeal of United Fuel Gas Company in 1956, it had declined to review any major rate order for 20 years. Moreover, the supreme court has imposed narrow limits on judicial intervention in the rate-making process. Rates established by the commission are considered final and not subject to judicial review unless they are beyond the power which the commission could constitutionally exercise, beyond its statutory power, or based upon a mistake of law. Water companies should, therefore, carefully plan presentations before the commission.

Procedural Lag

Although the rate-making procedure in West Virginia is fairly simple, and should, with proper planning, afford water companies ample opportunity for maintaining adequate rate structures, the problem of procedural lag has become increasingly important. This problem may be briefly illustrated as follows. If, during the first month of a given year, a company determines that its rates are inadequate, several months may be required before operating data can be verified and an accurate and current cost-of-service study completed. Additional time may be consumed by conferences with attorneys and in the preparation of legal papers. Several months may pass before either a petition or schedule is filed with the commission and, thereafter, the case may not be set for hearing for another two months. Assuming that the hearing is commenced towards the latter part of the year, several other months may be required for the presentation of the case, cross-examination, rebuttal, the filing of briefs and the completion of the hearing. The commission may take up to 90 days before it enters a final order. If the company is dissatisfied with the order and petitions for court review, a year or more may pass before the litigation is concluded. If it is assumed that the rates were inadequate at the time the company initiated the rate proceeding, the situation will have generally not improved during the lengthy period described. There will, of necessity, therefore, be a gap between the time of the discovery of inadequate rates and payment by the customer of the higher rates. The loss during this interim period is often increased by forces of inflation, and a serious problem for water companies results.

There are several solutions to the problem of regulatory lag. Following are a few recommendations:

1. Management should be more alert to rate requirements. No utility company should wait until its earnings are at a critical point before it decides to apply for rate relief. The management team should, at all times, have a running account of the company's financial position, should be able to forecast its future requirements, and should be prepared to expedite the application for rate relief.

2. Company exhibits and testimony should be made available to the commission and other interested parties prior to the hearing in order to avoid lengthy continuances.

3. The company should take advantage of prehearing conferences so that the commission and its staff will be conversant with company problems.

The modern rate proceeding should be considered a fact-finding process rather than a trial between adversaries.

4. Companies are often guilty of requesting more time than is necessary for the preparation of cross-examination data and briefs. Much time can be saved if the company itself is well prepared and willing to forego lengthy postponements.

The preceding suggestions are available to management alone; the following require the cooperation of the commission:

1. The problem of procedural lag is aggravated by the rigid use of the test period in rate making. Although rates are presumably made for the future, under the present rate-making formula they are based upon costs of service in previous years. Rates may be just and reasonable at a given time, but they are, in a sense, fictitious, because constantly rising costs of labor and materials produces an attrition in earnings. The use of an inflexible test period of prior years is therefore inequitable. The better practice would be to establish rates within a "zone" of reasonableness. A step taken in this direction by the West Virginia commission is the allowance of commodity clauses to power companies who purchase large amounts of coal. The possibility of escalator clauses for water companies for labor and material costs and for taxes should be explored.

2. The problem of procedural lag would be lessened if the commission were to permit a year-end rate base instead of an average rate base. If rate making is to be based upon concepts of original costs, the costs at the time of filing are far more accurate, realistic, and fair than those which have been averaged for the previous test year. Traditional averaging places a burden upon water companies in that the average rate base bears no direct relationship to actual operating conditions. Increases in plant do not automatically result in concomitant increases in revenues. Even in the careful and conscientious regulation of rates, there is necessarily a time lag between the discovery of inadequacy and the final order—with a resulting loss during the rate-making period. This loss is increased by the averaging of the base and necessitates multiple applications and filings. It is suggested that the use of a year-end base will help decrease the frequency of rate proceedings.

Conclusion

The problems of rate making for water companies are not easily solved. Regardless of the formalities and procedures followed, it is always difficult to fix a rate which is fair to both company and consumer. Cooperation in avoiding procedural lag, however, may produce fruitful results for both the company and its customers.

Determination of Water Rates in Wisconsin

Henry J. O'Leary

A paper presented on Sep. 28, 1956, at the Wisconsin Section Meeting, La Crosse, Wis., by Henry J. O'Leary, Chief, Rates and Research Dept., Public Service Com. of Wisconsin, Madison, Wis.

THE history of the regulation of water rates in Wisconsin spans about 50 years. Because of the fact that municipal utilities in Wisconsin have been subject to regulation during this entire period, the Public Service Commission has accumulated a wealth of experience and material in this field. So far as is known, no other regulatory commission has had an equal opportunity to observe and study the operation of water utilities. As a result of this long experience, coupled with the responsibility of providing rate schedules which are reasonable for both operators and consumers, the Wisconsin commission has developed certain basic principles and standards for the determination of reasonable rates.

The prices for most non-utility servicse are guided largely by competition. The furnishing of water service is usually a monopoly within a given area, thereby requiring the adoption of specific standards for the determination of reasonable rates. The formula adopted by most regulatory agencies is deceptively simple—a fair return on a reasonable rate base. However, this "simple formula" has, over the years, been productive of more litigation in the lowest and highest courts of the land than any other facet of rate regulation.

There is no purpose in burdening the reader with the history of litigation surrounding the proper method of determining a rate base. The various arguments on original cost, fair value, reproduction cost, and a number of variations thereof, are all familiar. The shifting sands of commission and court personnel, together with changing economic fortunes, have all contributed to the uncertainty surrounding the establishment of a reasonable rate base, and postwar inflation has revived the argument for giving greater weight to current costs.

Proper Rate Base

Throughout this turmoil, however, the Wisconsin commission has remained steadfast in its adherence to original cost as a proper rate base. It has been fortified in this position by decisions of the Wisconsin Supreme Court. As recently as Feb. 8, 1955, the Wisconsin Supreme Court stated (*1*) that "both the commission and this court are committed to the 'prudent investment' theory in rate cases. . . ." The legal support for, or acquiescence in the prudent investment theory is essentially no more than a reflection of the strong economic support which attaches to this position.

The protracted litigation which followed the establishment of the fair value rule of Smyth v. Ames (*5*), eloquently demonstrates the futility of attempting to maintain a legal fiction which does not conform to economic facts. Capital is the thing that is de-

voted to the public service by a utility, and that capital has a measurable cost which should be covered by the rate of return. Rates of return based on other concepts of value may result in either confiscation or the charging of excessive rates. On the other hand, the prudent investment theory, with its attributes of simplicity and stability, expedites the rate-making process and, at the same time, guarantees fair treatment to both rate payers and investors.

The Hope case, decided by the United States Supreme Court in 1944 (*2*), is generally regarded as a landmark in the granting of wide latitude to regulatory commissions in the determination of a rate base. In that decision, the court held that it is the result reached, not the method employed, which is controlling. The fact may be of interest that practically the same decision had been made 20 years earlier in 1924, by the Wisconsin Supreme Court in a case arising in this general area. In the Wisconsin-Minnesota Light and Power Company case (*3*), the court stated: "It is not the method that is to be reviewed but the result reached by the commission."

Net Investment Cost

On numerous occasions in the postwar period, the commission has expressed itself on the subject of the net-investment-cost rate base. The commission's decision of Apr. 9, 1952, in the Wisconsin Telephone Company case (*4*) embodies a thorough discussion of the matter. In that decision, the Wisconsin commission stated:

(3) This Commission does not wish to be arbitrary in rejecting a current-value theory and in adhering to the net-investment-cost theory. It is motivated primarily by practical considerations. The main objections against the reproduction-cost theory are inherent in the current-value theory. Both lack definiteness and stability. The use of current value would reintroduce the wild uncertainty and recurrent rate controversies which characterized the reproduction-cost era. The most serious vice would be that the use of such variable standards never leads to stability. As early as 1908, this Commission said: "Rates based upon valuations that rest on current prices would necessarily have to be changed with all changes in these prices. This would manifestly be impractical and, perhaps, also unjust both to the company and its customers. Prices of practically every element that enters into a plant are moving up and down so often that under no known method could the rates be changed and applied with equal frequency. . . . Rates should be as permanent as possible under the circumstances. Frequent changes are disturbing both to the companies and their customers. In order to secure the greatest possible permanency in the rates, it is necessary that the valuation upon which they rest should be subject to the fewest possible fluctuations (Hill v. Antigo Water Company, 3 W.R.C. 623, 639)."

In the language of Chief Justice Rosenberry in Wisconsin Tel. Co. v. Public Service Commission, 232 Wis. 274, 358 (1939): ". . . It is difficult to see why a valuation arrived at by guess on the basis of estimate should form the legal basis of depriving a litigant of its property, or be the justification for excessive charges to the public."

In the same decision, the commission also announced that it was willing to go on record at the time that it would approve any rate of return on a net-investment-cost rate base which is deemed necessary to achieve the reasonable end result required under the Hope case. That statement reflects the commission's realistic approach to the matter, and, further, that the prob-

lems of inflation can be solved by means other than inflating the rate base.

Inflation

It has also been urged that the ravages of inflation be recognized by increasing the rate of return so that equity capital will be compensated for the loss in the purchasing value of the dollar. From a practical standpoint, this problem is not too serious in Wisconsin, since practically all of the water utilities are municipally owned. On the other hand, both the statutes and considerations of fairness demand that both privately and municipally owned utilities be treated alike. The problems created by inflation are by no means easy to solve, principally because of the uneven impact of inflation upon our economy. It is obvious that a large segment of our economy is virtually helpless in offseting the income impairment due to inflation. The fixed-income type savings of people of small income—insurance and annuity policies, savings bonds, corporate bonds, and preferred stocks, to cite a few—are all victims of the loss in the purchasing value of the dollar. Yet regulatory commissions are constantly being importuned to select out of this group the equity owners of utilities, and, in effect, to place them in a preferred position with a sort of escalator or cost-of-living arrangement to insure them a dollar return with a constant purchasing power.

Thoughtful reflection upon the problem reveals that such a solution is utterly impracticable. Additionally, it could not be persuasively contended that it is a proper function of a regulatory commission to select a single group for preferred treatment, or to attempt to reallocate the incidence of inflation among various economic groups.

Function

The Wisconsin commission considers that the essential function of the rate of return is to provide the utility with sufficient dollar income to meet its current operating costs, and to provide profits in sufficient amount to attract to that utility the additional capital it needs to meet the standards of reasonably adequate service. Thus, the rate of return must satisfy current investors to the point that they will continue to provide capital at reasonable terms to the utility. To attempt to go beyond that point in fixing a rate of return, would be to venture into a field which is beyond the commission's jurisdiction, and which would be ill-advised in any event. Although not applicable in the case of municipally owned utilities, it is significant to point out that under existing income tax laws, the problem of correcting the inequities of inflation by increasing the rate of return, lays a very heavy burden on the customers, since it is necessary to collect $2.22 from them for each $1.00 of increase in earnings to common-stock holders. Under such circumstances, the customer might argue with considerable merit that he, too, needed protection from inflation, and that, in the interest of fairness, he should not be burdened with the cost of protecting the relatively few common-stock holders from inflation.

Depreciation Practices

Along the same lines, the argument has been advanced that present depreciation practices are not realistic, in that the depreciation allowed on the original cost of existing property is insufficient to cover present costs of

replacement. Some have advocated a complete change in depreciation allowances, and others have contended that this factor should be considered in determining an increased rate-of-return allowance. There appear to be wide misconceptions concerning the proper function of the annual depreciation allowance. Depreciation is considered by the commission as one of the costs of doing business. It represents a cost by virtue of the fact that over the years the property to which it is applicable deteriorates and eventually becomes no longer serviceable. The proper function of depreciation is the assignment to each year of the life of a property unit a proportionate part of its cost, so that at the end of the period, the full net cost of the unit will have been recovered. Depending upon economic conditions at the time of retirement, the amount recovered may be less than, more than, or equal to the cost of replacement. There are many techniques advocated for distributing the cost over the life of the property, such as straight line, sum of the years' digits, declining balance method, and others. It is significant, however, that all of these methods deal with cost rather than replacement value.

In the process of developing depreciation on a cost basis, it is necessary to make estimates of service lives, salvage values, and cost of removal. Despite these variables, it is possible to devise annual depreciation rates which equitably distribute the cost of property consumed in service, over its life. These estimates are completely acceptable for tax and financial purposes, and, most important of all, assess, against the current customers, the costs incurred in furnishing service to them. An attempt to recover estimated replacement costs over the life of existing property would add an element of extreme uncertainty, and, furthermore, would require present customers to pay costs on property devoted to the use of future customers.

There are many items of property now being used, which will be replaced with property which is more efficient or useful. Even if we ignore inflation, the cost of the replacement item may be greater because of its greater utility. Future customers will get the benefit of greater efficiency through reduced operating costs. It would be unfair, therefore, for them not to pay the higher depreciation costs. Certainly, present customers should not be required to pay higher depreciation costs without receiving the benefits of lower operating costs which result from the improved efficiency of the new units. Typical examples of this are provided in new steam-generating units and automatic telephone-switching equipment.

Replacement costs which are higher because of inflation, are immediately reflected in the rate base, and, thereafter, increase both depreciation and rate-of-return requirements. Therefore, the current crop of customers is required to provide revenues which will support the increased investment. Neither annual depreciation nor rate-of-return allowances are designed to provide the utility with the new capital required because of inflated prices. They are designed, however, to keep the utility in such financial condition that the additional capital can be acquired at reasonable terms.

The impact of inflation on the cost of service becomes evident as the investment per customer increases. The extent of the impact depends upon the comparative rates of growth in the prewar and postwar periods. In any event, as replacements are made, the

cost of serving prewar customers is increased under any method of allocation. It has been argued in some places that some method should be devised whereby the old customers would be exempt from the higher costs associated with the attachment of new customers and the demands for service of the new customers. Obviously, it is impracticable to make such a separation, and both old and new customers must share in the current costs of service. However, it is possible to achieve a greater measure of equity in water utility service than for most other utility services. Through assessments and extension rules, it is usually possible to recover, from new customers, the current costs of main extensions and service connections, which represent a large portion of that part of water works investment made on their behalf.

The observations in this discussion have been confined to some rather basic principles affecting the rate-making process, and, particularly, the impact of inflation on the rate problem. The methods followed by the commission in converting revenue requirements into rates are quite generally known and, under the circumstances, there is no need to discuss specific rate applications.

References

1. *Milwaukee and Suburban Transport Corporation* v. *Public Service Commission* (268 Wis. 573).
2. *Federal Power Commission* v. *Hope Natural Gas Company* (320 U. S. 591).
3. *Wisconsin-Minnesota Light and Power Company* v. *Railroad Commission* (183 Wis. 96).
4. *Wisconsin Telephone Co.* v. *Public Service Commission* (37 P.S.C.) of W. 166).
5. *Smyth* v. *Ames* (169 U.S. 466).

Determination of Municipal Water Rates

Albert P. Learned

A paper presented on Sep. 14, 1956, at the North Central Section Meeting, St. Paul, Minn., by Albert P. Learned, Prin. Engr., Black & Veatch, Kansas City, Mo.

THE matter of municipal water rates has almost become a hackneyed subject in recent years, and would long ago have been so if it were not so vital a factor in the successful operation of all water systems. The subject of rates seems unduly simple to some, and unduly complicated to others.

It is the purpose of this paper to delineate certain familiar facts of the water business, to show the occasion for the increase in water rates, and to show further that the appropriate rate schedule is a conversion of such facts and their related costs in a way that distributes these costs equitably between customers. These customers are normally divided into customer groups, such as domestic, commercial, and industrial. Water rates, however, do not often reflect such customer grouping, as electric rate studies commonly do, but a proper rate analysis cannot ignore such differences if all general considerations are to be properly reflected in the rate schedules.

It is practically axiomatic to say that water has been sold to the customers of municipal systems at too low a charge for several decades. This phenomenon has been accomplished through different methods or combinations of methods, among which have been:

1. Capital outlays for interest and amortization of extensions and other improvements, paid for by funds raised through general taxation, and not reflected in the schedule of water rates

2. Omission or inadequate provision of funds for depreciation in rate schedules

3. Abbreviated, inadequate maintenance

4. Exhaustion of all growth capacity in the production, storage, and main trunks of the distribution system, and a policy of barely getting by instead of preparing for increased requirements before they become imperative.

New Developments

Developments in recent years have aggravated the situation, and emphasized the water rate schedule deficiencies. These developments, many of which were summarized by Wolman (*1*) in discussing the problem of providing reasonable water service include:

1. An unexpected and unprecedented growth in urban population

2. A wider distribution of urban and suburban population, due largely to wider automobile ownership which makes it unnecessary for workers to reside near their employment. (The same tendency to disperse, shown by industry—in an effort to locate where there is adequate space for employee parking—has complicated water system feeders, and, in many instances, resulted in large investments which do

not pay well now, but will be more lucrative in the future.)

3. The building of ranch type and single-story houses fronting lengthwise on the street (resulting in a larger lawn area in front of the house), and the provisions for auto parking at the home and at large industrial installations, which have resulted in longer average length of mains per family or industry served

4. The increase of costs of materials and labor over the levels which existed prior to the end of World War II, and on which many of the water rates were based. (Some water rates still embody reductions made at the low point in the depression, when there were no requirements for new capital, and when many schedules barely reflected operating costs, and made little or no provision for depreciation.)

5. The extreme difficulty experienced by municipal governments in providing general services of policing, fire fighting, street cleaning, sewer system operation, and other services because of inadequate taxing provisions by state legislatures (This has caused many municipalities to discontinue payments to the water department for fire protection facilities. Fire protection is one of the major functions of a water works system, and its overall importance derives more from the value of the property protected than from the water consumption of the customer.)

6. Present living standards which have increased the amount of water needed (Most dwellings, in most cities, are equipped with reasonably complete sanitary facilities. In certain sections of the country, some of the customers are equipped with air conditioners that are either of the water conserved or nonconserved type.)

7. The decentralization and the growth of industry which have brought industry to many cities (The new industry's needs are added to the former requirements of the city system and, in some instances, the water requirements of such an industry constitute a substantial addition to the entire community requirements. Growth of industry has added, too, to the load of the water systems of older, well-established industrial centers.)

8. The accumulated growth, in the war period, during which expansion of system capacities was practically impossible. (This growth was met reasonably well at the time because of better load factors which disappeared after the war, producing increased peak requirements on the system.)

The above conditions have resulted in instances where a new supply facility had to be developed, or an old one materially expanded, or both, and where the transmission or trunk main framework had to be materially enlarged or extended, or both. Similar conditions resulted where the storage facilities had to be added to by increase in size or added locations, or where the distribution facilities were materially enlarged.

All of these had to be done at a cost per unit of plant materially higher and, in some instances, at several times the average cost of the corresponding unit in the existing plant. Labor costs, reflected in operating expenses, have naturally also increased, as has the cost of practically all supplies since the end of World War II. Municipalities have to finance on the basis of retirement of debt during a period much shorter than the life of the property. Increasing prices make it necessary to have more funds available for debt purposes per unit of property, and, since the source of funds is the sale of water,

the cost of water must be increased to insure the solvency of the utility.

The end effect of all of these conditions has been, in many instances, an unusually large increase in water rates which were originally altogether too low.

The water works industry is confronted with the additional problem that it has but one peak period as compared to the electric industry which has a winter and summer peak of like dimensions. The water industry's summer peak normally occurs when its supply of water is at its low point. Furthermore, the principal causes of the peak—lawn sprinkling and air conditioning—occur at the same time, while in the electric industry, the peaks are caused by a lighting load in the winter and an air-conditioning load in the summer. Such conditions result in a more satisfactory annual load factor and a more general use of all production facilities.

Metropolitan Policy

A number of the larger cities of the country are faced with the question of whether they should build a production, storage, and trunk system sufficiently large to become the supply source for a metropolitan area. There are further questions of how to handle such a project, and the extent of the obligation of a large city to meet such a challenge.

Kansas City, Mo., with a limited amount of water, has resolved this problem by establishing a schedule of charges at the city limits to suburban water districts and water companies. The basis of such charges has been incorporated in a demand and commodity schedule. The demand charge has been based on the maximum daily demand in June, July, August and September (the peak period) in any year, plus an hourly demand occurring during the same period and between the hours of 4:30 and 8:30 PM on any day, except Sundays and holidays, and reflecting the maximum hourly demand over the maximum daily rate of demand. The actual demand charge varies at different points of connection due to the allocation of the trunk and feeder mains involved. The demand charge includes the fixed charges and operating expenses involved in the allocation of production and pumping plants, and trunk and feeder mains. It reflects a return on the investment in line with a private utility return. Because of a lack of assurance of a continued supply commensurate with their needs from the city of Kansas City, two of the private companies operating in the Kansas City suburbs who are purchasing water from the city, are building their own production plants.

Cincinnati negotiated a 20-year contract with Hamilton county, after the county investigated the matter of an independent supply. The rate to the outside customers is double that of those in the city. The maximum spread for county rates is the same as that for the present city rates. The city calculated the rate on a basis that would produce a return of 5 per cent on the plant associated with serving the suburban area. The city is obligated to build, at its cost, the necessary pumping stations and trunk mains in the suburban areas to serve the distribution systems built by the customers, and to maintain, operate, and replace any of the property in the suburban system. The city reads the meters and also does the billing and collecting. The operation is actually handled as though it were a part of the system within the city limits, except for the rate applied and the initial

outlay of capital in the distribution system proper.

A recent (May 1956) decision of the Montana Supreme Court, in *Crawford* v. *City of Billings,* deals with a city's obligation to serve rural special-improvement districts. The following extract from the decision is of interest because it contains fundamental reasoning which is generally applicable, and not peculiar to that community:

> It is not to be denied that the city of Billings, in the operation of a municipal water system, is a public utility in most meanings of the phrase, particularly so far as its own inhabitants are concerned, and it is not the law that a municipality can be forced to construct mains beyond its corporate limits solely because it is operating a public utility in the shape of a municipal water system. This is true, although it has the power, as Billings does, being a city of over 24,000, to deliver water beyond its corporate limits. . . . Territorial limit of services supplied is everywhere found. It is not to be denied that a privately owned utility may limit the territory it professes to serve; laws, physical powers, finances—all act to limit. And, as has been asked, what is more natural or proper, in the case of cities, than that the extent or kind of service shall be limited to the boundaries of the city? To hold that a city may be compelled to extend its main beyond its limits, and then, as a natural result, to serve and maintain them, merely because it is operating a municipal water system, could lead to endless difficulties for the city, financial and otherwise, and make it the prey of every unwise or unscrupulous promoter of subdivisions or other enterprises. . . . The city cannot be thus compelled to burden its public utility, and perhaps itself, by providing conduits to persons who are out of the city's limits and beyond its taxing powers.

TABLE 1

Water Usage by Customer Group *

Group	Percentage of Total		
	Bills	Consumption	Revenue
Residential			
In city	85.16	45.16	60.45
Outside city	4.95	3.09	7.24
Commercial			
In city	9.46	51.31	31.34
Outside city	.43	.44	.97

* Based on a study of a system having more than 5,000 customers.

The extension of the main is specifically mentioned in this case, and the apparent implication is, that it would involve the works sufficiently to warrant rendering of service, if such extensions of mains were made. Such metropolitan area problems differ to some extent in each area, and solutions are influenced by legislative powers, public policy, and physical and financial considerations.

Group Usage

Data of a recent study of a water system having more than 5,000 customers are shown in Table 1, and use by several groups of customers, given as a monthly percentage of total annual sales, is shown in Table 2.

It will be noted that residential customers in the city have the greatest variation between winter and summer use, except for the commercial customers outside the city, who were small in number and included customers who would have a decided summer peak.

The breakdown of residential customers in the city who use less than 25,000 gal in any month and those who use more than 25,000 gal in one

or more months of the year, is given in Table 3. It is apparent that the single family group using 25,000 gal or more in any one month of the year was the group creating the major fluctuation in usage and a major contributor to the increase which produced the system peak. The peak in this instance was created in part by lawn sprinkling and in part by nonconserved air conditioning. The ratio of responsibility for peaking between lawn sprinkling and air conditioning has not been determined.

The necessity of a sufficient minimum charge was apparent from the analysis of total residential bills shown in Table 4. Fifty per cent of the bills were for 3,000 gal a month or less, and 73 per cent for 5,000 gal per month or less. The record showed that the annual load factor for the system, based on the average day to the maximum day pumpage, was 51.4 per cent, and if that had been similar to an electric comparison, where a 30-min or 1-hr peak usage is used, this annual load factor would be a great deal less—probably more nearly 20 per cent than 51.4 per cent. Storage, of course, obviates production capacity equal to the maximum 30-min or hourly peak. This system has a substantial industrial load that increases the load factor.

A check of the maximum hourly demand of one of the private companies which buys water from Kansas City, Mo., and has over 5,000 customers, indicates that its annual load factor, based on the maximum hourly peak, is approximately 10 per cent, and, when based on the maximum day pumpage, 44 per cent. This system has a relatively small industrial load.

A comparison of these hourly and daily load factors with electric load factors for corresponding periods illustrates some of the difficulties of the water business, even though water can be stored to meet sharp, yet short, high demands.

TABLE 2

Water Usage by Customer Group per Month

Month	Percentage of Annual Total				
	All Sales	Residential Sales		Commercial Sales	
		In City	Outside City	In City	Outside City
Jan.	6.05	5.83	5.60	6.28	5.63
Feb.	6.23	5.36	5.15	7.07	5.47
Mar.	6.14	5.32	5.20	6.92	4.96
Apr.	7.47	6.96	6.83	7.97	6.82
May	8.71	8.96	9.51	8.46	7.22
Jun.	7.90	7.48	6.68	8.35	6.78
Jul.	11.20	11.57	9.99	10.94	10.11
Aug.	11.19	12.14	12.78	10.27	10.55
Sep.	11.57	14.42	12.99	8.95	14.67
Oct.	7.42	6.72	8.60	7.92	12.08
Nov.	8.62	8.38	9.24	8.80	8.49
Dec.	7.50	6.86	7.43	8.07	7.22

The comparison of sales per mile of main often is indicative of why water rates are higher in certain localities than in others. Results of a study of 23 companies on that basis are given in Table 5.

The lowest sales per mile of main in 1945 and 1955 were by the same company operating in a suburban area with a small number of industrial sales. It had over 6,000 customers in 1945 and over 21,000 customers in 1955. Its rates are necessarily high when compared to many older companies.

Investment Increases

A recent statistical study of 25 companies is enlightening as to the increased investment that has occurred in the period from 1945 to 1955. In two of the companies the relationship between 1944 and 1954 was used because 1955 data were not available. Table 6 gives the totals for the 25 companies studied.

The data reflect increases of 98.2 per cent in plant account, 53.1 per cent in the number of customers, and 29.4 per cent in the plant account cost per customer. The 1945 range in the plant account per customer, varied from $170.23 to $430.13, except for one system which purchased its water and showed $121.35 per customer. In 1955 the range in plant account per customer varied from $247.93 to $521.81. A similar comparison of four municipal water utilities is shown in Table 7. The data here reflects increases of 92.2 per cent in plant account, 51.0 per cent in customers, and 27.3 per cent in plant cost per customer. It will be noted that the percentages are in line with the findings on the 25 privately owned water utilities.

TABLE 3

Breakdown of City Residential Consumption

Month	Average Consumption per Month—*gal*			
	Less Than 25,000*		More Than 25,000†	
	Single Family	Multi-family	Single Family	Multi-family
Jan.	3,110	6,140	4,750	17,330
Feb.	2,840	5,640	4,580	16,670
Mar.	2,690	5,640	4,960	21,690
Apr.	3,570	7,160	6,790	22,400
May	4,340	7,200	14,710	22,060
Jun.	3,710	6,380	10,500	19,030
Jul.	5,530	8,890	19,130	28,410
Aug.	5,610	7,700	23,780	30,130
Sep.	6,260	8,770	34,230	33,910
Oct.	3,280	5,520	8,860	22,650
Nov.	4,060	7,510	9,910	32,710
Dec.	3,410	6,830	6,260	28,780
Annual average	4,040	6,950	12,430	24,770

* No more than 25,000 gal in any month.
† More than 25,000 gal in one or more months per year.

If one were to assume for comparative purposes that the plant serving the customers in 1945 was relatively the same as to capacity, efficiency, and other vital respects with the plant in 1955, and that the added plant investment reflects plant built to serve the added customers, namely $198,303,786 to serve 402,094 added customers, the average investment per new customer has been $493.18. In none of the companies studied has the investment per customer in 1955 been less than the investment per customer in 1945. A rate that would have supported the prior investment per customer will be inadequate to support the increased capital costs of the present.

TABLE 4

Analysis of Total Residential Bills According to Usage

Gallons of Usage per Month	Percentage of Total Bills
1,000 or less	17.45
1,000–2,000	16.84
2,000–3,000	16.48
3,000–4,000	12.71
4,000–5,000	9.42
Over 5,000	27.10

Municipal water utilities normally escape the many tax liabilities of a private utility, but the typical municipal water utility has to amortize its debt over a relatively short period when compared to the life of the property. The private utility does not reduce its earnings base except through depreciation, which is keyed to the expected life of the property.

Plant and maintenance costs have increased materially in the 1945–1955 period. A few of such unit costs are representative which can be found in Table 8.

The major addition to a water utility's peak requirements in recent years has been the introduction of nonconserved air-conditioning equipment, in which the water is passed through the cooling section but once. This has proved to be a serious load-building element because it is imposed during the normal peak season of a water utility, its usage is high when in service, and its time of usage is but a small part of a year. Additional facilities are required, and there is little time for a privately owned utility to secure an adequate return, or for a municipal utility to earn funds sufficient to amortize and pay interest on the debt thus incurred.

W. Victor Weir has summarized the problems and costs of such service (*2*), and has vividly brought out the serious features of this type of load as compared to lawn sprinkling—in which there is a marked diversity in use. Fargo, N.D., in this area, has adopted the special charge for such service. The problem varied in its importance dependent in part upon the latitude and in part upon the frequency and intensity of hot days in the same latitudes.

TABLE 5

*Data on Sales per Mile of Main in Gallons**

	1955	1945
Average	12,177	11,471
Highest	18,628	20,692
Lowest	4,166	1,424

Rates are in different forms: the General Waterworks Corporation in Arkansas secured a decision from the state's regulatory commission to charge $12.50 annual surcharge per ton for nonconserved units; others have adopted modifications of such a charge by making it a monthly charge for a certain number of months, but arriv-

ing close to the same total as an annual surcharge. Weir developed a logical annual surcharge of $40 per ton of nonconserved air conditioning for his company. The impact of this load will have different effects on different systems. In some companies its effect may be confined generally to the production plant; in others it may also require additions to a substantial part of the trunk main system, and, in still others, it may require revision in storage facilities.

All operators of water systems recognize that lawn sprinkling creates a problem. This problem, however, lends itself generally to a reasonable solution, except in a few remaining communities where flat rates are in effect. In such cases, policing seems to be the only method of exercising any control on lawn sprinkling, and there its success is limited. It is singular that many of our flat rates are in communities where water has to be brought for long distances, and where the plant cost is high. In some of these areas, operating expenses are not necessarily low. Such communities should appreciate the value of water and should make every effort to conserve water. The most effective method to accomplish it is by metering since its benefits are more equitably distributed on a property valuation basis than by the amount of water consumed by each water customer (This cost allocation involves fixed charges on production plant, storage and pumping plant, trunk mains, and hydrants.)

2. Assignment of responsibility for peak consumption according to customer groups (This involves practically the same plant elements as are included in the fire protection allocation, and the same fixed charges. These are allocated in accord with the demands.)

and by providing in the rate schedule all of the protective features required to insure equity among customers.

Rate Schedule

This paper has primarily outlined causes for the needed revisions in water rates and stated some of the problems the operator has had to confront and solve. The next step is the conversion of those facts into financial terms by the following steps:

1. Proper evaluation of the costs of fire protection and general water service and the assumption of the fire protection charge by the general public,

TABLE 6

Changes in Water Company Status Over 10-Year Period *

	1945	1955
Plant account	$202,000,372	$400,304,248
Number of customers	757,190	1,159,284
Average investment per customer	$266.78	$345.30

* Data given are totals for 25 companies studied.

TABLE 7

Change in Status Over 10-Year Period of Four Municipal Water Utilities

	1945	1955
Plant account	$52,666,690	$101,247,536
Number of customers	174,426	263,352
Average investment per customer	$301.94	$384.46

3. Allocation of commodity costs to the respective groups according to the commodity sold (The commodity expenses include all operation and maintenance expenses not directly chargeable to fire protection, customer costs, or special services. Customer costs are those incurred in the reading of meters, billing and collecting of revenues, plus the operation and maintenance of services and meters. The major part of distribution expenses are also included in this charge.)

5. Special charges for nonconserved air conditioning, designed to insure a more equitable subdivision of demand costs.

The writer's experience has indicated that water rates and minimum charges have generally been too low and brackets in rate schedule have often been too short, permitting many customers to purchase water at the minimum rate before having produced enough revenue to reflect their fair share of total costs of service. The last bracket in rate schedules has often been too low, reflecting more nearly an incremental cost rather than a charge that recognizes use of facilities, as well. Water rate revisions are often delayed because of reluctance on the part of municipalities or boards to face facts until the department is in a precarious operating condition—particularly in meeting its peak requirements. Too many treat water as free, failing to realize the cost of the plant to deliver it, the cost of preparation of the water so it may be safely used, and other special problems of delivery dependent upon rate of delivery, topography, and general layout of a community. It should be remembered, too, that the cost of water seldom, if ever, is the controlling element in the location of an industry, it is the amount of water which is available that may have some influence.

Water is our most valuable asset as far as life is concerned, and should be sold at reasonable rates, but at rates that will permit the furnishing of adequate and satisfactory service. The equitable distribution of those costs between customers is imperative, and rate schedules should provide special charges where necessary to insure the equity of service costs.

TABLE 8

Increases in Typical Plant and Maintenance Costs

	1945	1955
Cast-iron pipe, 6-in.—per ton, fob Birmingham, Ala.	$45.00	$106.80
Copper electrolytic—per pound at basing point	12.00	38.20
Lead—per 100 lb, St. Louis	5.70	12.23
Zinc—per 100 lb, E. St. Louis	8.25	14.90
Steel pipe, 3-in., butt weld, galvanized, at basing point—per ton	80.74	161.74

References

1. Wolman, Abel. Providing Reasonable Water Service. *Jour. AWWA*, **47**:1 (Jan. 1955).
2. Weir, W. Victor. Surcharge for Nonconserved Air Conditioning in St. Louis County. *Jour. AWWA*, **47**:1091 (Nov. 1955).

Diatomite Filters for Municipal Installations

E. Robert Baumann

A paper presented on Oct. 24, 1956, at the Iowa Section Meeting, Des Moines, Iowa, by E. Robert Baumann, Assoc. Prof. of Civil (San.) Eng., Iowa State College, Ames, Iowa.

THE use of diatomite filters for the filtration of water has greatly increased since their early development by the US Army in World War II (*1*). Shortly after the war, these filters were used extensively for high-rate swimming pool water filtration. As operating data and experiences became available (*2, 3*), the filtration rates were decreased to 3 gpm per square foot and more successful operations were obtained. In some states more than half of the new pools being constructed are equipped with diatomite filters.

During recent years diatomite filters have been proposed for use in the filtration of potable water for municipalities. In 1950 and 1951, Sanchis and Merrell (*4*) conducted studies to determine the feasibility of using such filters on the Los Angeles water supply. In the period 1946–1953, the theory of the operation of diatomite filters was studied at the University of Illinois under contract with the US Army (*5–9*). As early as 1949, several diatomite filters were approved for municipal use in New York and Illinois (*10*). The operating results from only one of these plants (Cherry Valley, N.Y.), have been described in detail in the literature (*11*). The operating results of sand and diatomite filters on a potable industrial water have recently been compared (*12*).

There is a need for additional information about diatomite filters and their application in potable water filtration. To determine what areas of diatomite filtration require further study, the Iowa Engineering Experiment Station conducted a preliminary evaluation of diatomite filters in municipal installations. The study was conducted in two phases: [1] the completion of a questionnaire survey to determine current health department attitudes and experiences with municipal diatomite filters; and, [2] the evaluation of existing municipal installations by means of an inspection visit to obtain plant design and operating data.

Questionnaire Survey

Plans and specifications for water treatment plants must usually be submitted to the state health department for review and approval before plant construction is begun. For that reason it was assumed that state health departments would represent a valuable source of material for evaluating the feasibility of using diatomite filters for the filtration of potable water supplies. A questionnaire form was prepared and copies were dispatched to the health departments. Essentially, the aim was to discover:

1. Whether the state health department would approve diatomite filters on municipal water supplies
2. Whether any change was contemplated in their approval policy
3. What filter design or other considerations were evaluated in review-

ing proposed municipal diatomite filters

4. Whether any diatomite filtration plants had been built in the state and whether they were satisfactory.

The survey questions were kept few in number and brief to encourage return of the complete questionnaire. The questionnaire, together with an explanatory letter and return envelope, was mailed to the directors of the engineering divisions of the 48 state health departments and of the health departments of Alaska and Hawaii. All questionnaires were returned.

Questionnaire Results

The results of the questionnaire pertaining to the present attitudes and policies of health departments with regard to municipal diatomite filters are summarized in Table 1. No states contemplated changing policy within the next 12 months.

TABLE 1

Summary of State Health Policies Pertaining to Municipal Diatomite Filtration Plants

States Not Approving

Alabama	Georgia†	Missouri‖	Pennsylvania
Arizona	Kansas‖	New Jersey	Tennessee
Arkansas* ‖	Kentucky	North Carolina	Texas
Connecticut	Louisiana‖	Ohio	Utah
Florida	Mississippi	Oklahoma	Washington‖

States Having No Fixed Policy

California	Maine	Montana	South Carolina
Colorado	Maryland	Nebraska§ ‖	South Dakota
Indiana‡	Massachusetts	New Hampshire	Vermont
Hawaii		North Dakota	

States Approving

Delaware	Oregon
Nevada	West Virginia
New York	Wyoming

States Approving With Reservations

Alaska (experimental plants only)
Idaho (might approve when used in well-protected and nonpolluted source for turbidity removal)
Illinois (with reservations)
Iowa (might approve on a well supply, not on a surface supply)
Michigan (will approve only on Midland–Saginaw pipeline and perhaps Lake Superior water)
Minnesota (might approve on a safe well supply but not on a surface supply)
New Mexico (conditional approval)
Rhode Island (approve on experimental plant only)
Virginia (will approve for iron removal or where chlorination alone produces safe supply, will not approve for surface supply)
Wisconsin (will approve on a safe well supply, but not on a surface supply)

* May later consider their use for purpose other than for bacteria removal.
† Will approve for emergencies only.
‡ Would approve for iron removal. If satisfactory there, might approve for turbid surface water.
§ Presently would *not* approve.
‖ Poor experience with swimming pools led to present policy opposed to diatomite filters for municipalities.

Many of the state health departments which will not approve or which resist the installation of diatomite filtration plants for potable water supplies indicated that such resistance springs partly from:

1. Prejudice based upon observation of poorly designed and poorly operated diatomite filtration plants for municipal or swimming pool water
2. A definite lack of reliable and adequate data for successful evaluation of diatomite filter performance over a wide range of water qualities
3. The widespread unfamiliarity with diatomite filters and their principles of operation
4. An unfounded belief that all diatomite filters are difficult and expensive to operate
5. The danger that raw water might pass unfiltered through the thin layer of diatomite filter aid on the filter septum. This feature, inherent in diatomite filters, probably constitutes one of the major reasons for state health department resistance to diatomite filters for municipal water filtration.

TABLE 2

Considerations for Approval

State	Points Considered
Alaska	Purpose of filtration; availability of competent operating personnel; climatic conditions and water temperature; considered experimental plants.
Delaware	Evaluate detailed plans and specifications; consider purpose of plant, basis for design, filter rate, rate control, and so on
Idaho	Would a health hazard be introduced or eliminated by the use of diatomite filters?
Illinois	Quality of raw water. Quality and purpose of filters
Michigan	Each installation considered on its own merits
Nebraska	Dependability; good operating instructions; one year of successful operation elsewhere; justify their superiority to sand filters
Nevada	Plant must accomplish intended result
New Mexico	Purpose of filters; size of community; operating personnel
New York	Purpose intended; turbidity of raw water to 10 but not greater than 30 ppm; not approved for color removal; not approved for iron removal unless iron is completely precipitated
Oregon	Practicability in proposed application
West Virginia	Judge each case on its merits
Wisconsin	"Must justify" each installation

In the questionnaire, each state was asked to detail the points considered in evaluating the feasibility of a proposed installation. Although sixteen states have indicated that they would approve

municipal diatomite filtration, only twelve attempted to outline the points they had considered in evaluating specific installations. The policies followed in these states are summarized in Table 2.

A review of the points outlined in Table 2 indicates that all states chiefly consider the fact that the plant must be capable of performing as planned. Only New York attempted to list conditions under which such filters would or would not function. In all probability, the lack of definite stated criteria is chiefly due to the fact that such criteria are not as yet available to the profession.

As of Aug. 1, 1956, a total of 29 municipal diatomite filtration plants had been constructed in ten states and Alaska. Table 3 lists the data pertaining to each installation obtained from the questionnaire. Of the total of 29 plants installed, four plants have since been abandoned. Unfortunately, the questionnaire data were not extensive enough to determine whether the plants were unsuccessful due to poor plant design, poor operation, or the application of diatomite filters to a nonfeasible type of operation. Additional data are being sought about each of the abandoned plants.

The locations of the municipal plants are summarized in Table 4. The sources of water for municipal installations using the filters are given in Table 5.

Inspection of Plants

In the second phase of the preliminary study, the author made an inspection visit to sixteen of the municipal diatomite filtration plants listed in Table 1. The feasibility of municipal diatomite filtration plants was determined by an evaluation of: [1] the purpose of each plant; [2] the source of the water; [3] the installation and its equipment; [4] the adequacy of the operating procedure; [5] the operating results; and [6], the capabilities of the operator.

Most of the 29 municipal diatomite filtration plants are located in Michigan and New York. As a result, an inspection trip was conducted in which the following fourteen plants were inspected in a period of 5 days: Aus Gres, Linwood, Kawkawlin, Saginaw Township, Carrollton Township, Bangor-Monitor Township, Auburn, and Belleville, in Michigan; and Tupper Lake, Cherry Valley, Palmyra, Copenhagen, Gasport, and Lyndonville, in New York. The trip was made in a light airplane and a rental automobile was used for local travel to each of the plants. Visits have also been made to the plants at Mounds, Ill., in 1950, and at Worthington, Minn., in 1955.

The objective at each of the plants visited was to gather and record data pertaining to its physical installation and operating characteristics, with special interest in the cost and effectiveness of the treatment. The operator of the plant was usually asked to describe the purpose and operation of his charge and to discuss its capabilities. The author inspected the physical installations to determine the plant characteristics. If the operator could not be located, the mayor or other responsible official was asked to serve as a guide on the visit. A form record was used to collect the data obtained during each visit.

Source and Quality—Lakes

Seven of the diatomite filtration plants visited in Michigan derived their raw water supply from the Midland-Saginaw pipeline. A central pumping station pumps raw, prechlorinated Lake Huron water through a 48-in.

TABLE

Municipal Diatomite Filtration Plants

Location	Pop.	Health Dept. Approval	Year Built	For Removal of
1. Seal Beach, Calif.	3,553	no	1950	taste
2. Campbell Hill, Ill.	336	yes	1950?	iron
3. Mounds, Ill.	2,001	yes	1949	iron
4. Auburn, Mich.	900	yes	1952	turbidity
5. Aus Gres, Mich.	450	yes	1950	turbidity
6. Bangor—Monitor Metr. Dist., Mich.	1,000	yes	1952, 1956	turbidity
7. Carrollton Township, Mich.	3,500	yes	1950	turbidity
8. Kawkawlin Met., Dist., Mich.	700	yes	1952	turbidity
9. Linwood Met. Dist., Mich.	500	yes	1955	turbidity
10. Saginaw Township, Mich.	10,000	yes	1954	turbidity
11. Belleville, Mich.	1,800	yes*	1954	turbidity, plankton
12. Worthington, Minn.	7,900	no	1955	turbidity, plankton
13. Santa Rosa, N.M.	3,000	yes	1950, 1954	turbidity
14. Cherry Valley, N.Y.	760	yes	1949	turbidity
15. Copenhagen, N.Y.	539	yes	1953	turbidity
16. Gasport, N.Y.	800	yes	1949	turbidity, Fe, Mn
17. Greenwood Lake, N.Y.				
Winter	819			
Summer	4,000	yes	1954	turbidity & algae
18. Lyndonville, N.Y.	777	yes	1955	turbidity & algae
19. Montrose Water Dist., N.Y.	9,000	yes	1955	turbidity
20. Palmyra, N.Y.	3,034	yes	1956	turbidity
21. Sherburne, N.Y.	1,600	yes	1953	iron, color, turbidity
22. Tupper Lake, N.Y.	5,440	yes	1952	turbidity, iron, color, algae
23. Willsboro, N.Y.	838	yes	1952	turbidity
24. Lake Wister, Okla.		no		turbidity
25. Estacada, Ore.	950	yes	1955	turbidity
26. Yoncalla, Ore.	626	†	1954	turbidity
27. Bedford, Pa.	3,600	no	1955	turbidity
28. Norton, Va.	4,315	no	1954	iron
29. Anchorage, Alaska	500	yes	1955	turbidity

* Temporary
† Experimental

pressure conduit to the large cities of Midland and Saginaw, Mich. Several small cities and numerous individuals are permitted to use the pipeline as a source of water. Individuals are permitted to use the water without further treatment. Small towns, however, are required by the State Health Department to filter the water.

Aus Gres, Linwood, Kawkawlin, Saginaw Township, Carrollton Township, Bangor-Monitor Township, and Auburn, Mich., all towns having a population range of 400 to 10,000, take water from the pipeline and filter it through diatomite filters. The towns nearer the pipeline intake, Aus Gres and Linwood, require no pumps, as the

3

in the US to Aug. 1, 1956

Raw Water Source	Operating Results	Remarks
wells	unsatisfactory	plant abandoned
wells	unsatisfactory	plant abandoned
wells	unsatisfactory	plant abandoned
Midland–Saginaw pipeline	satisfactory	
Midland–Saginaw pipeline	satisfactory	
Midland–Saginaw pipeline	satisfactory	
Midland–Saginaw pipeline	satisfactory	
Midland–Saginaw pipeline	satisfactory	
Midland–Saginaw pipeline	satisfactory	
Huron River	satisfactory	temporary alternate supply
Okabena Lake	excellent	city owned plant supplying industry only
Pecos River	good	private utility
Brook & impounding res.	very good	excellent records, short filter runs in spring
Deer River	satisfactory	
East Brook & impounding res.	good	
Greenwood Lake	problems	excessive organisms, auxiliary supply May–October
Lake Ontario		supplements slow-sand filters
Catskill Aqueduct	satisfactory	vacuum filter, intermittent use
Canandaigua Lake	satisfactory	
Mad Brook, aux. well	good	
Tupper Lake	good	auxiliary summer supply
Lake Champlain	good	
Lake Wister		recreational area, experimental
Clackamas River	good	
small stream	fairly good	improves water markedly
Raystown branch of Juniata River	poor	plant abandoned, short filter runs
abandoned coal mine		temporary source approved without filtration
Ship Creek	fair	serves native hospital only

pressure is high enough for both filtration and service. As the distance from the intake increases and the pressures decrease, supplemental or booster pumps are required during periods of high water demand.

The raw water usually contains about 0.5–0.8 ppm of chlorine residual. The water turbidity is usually very low. Over a period of 23 months, a turbidity of 8 ppm was equaled or exceeded on only 30 days. The maximum turbidity recorded during this period was only 27 ppm. The chief chemist at the Saginaw water plant indicated that the water turbidity varied between 2 and 80 ppm.

The operators of all of the plants reported excellent removal of turbidity, but only partial removal of color. Varying with grade of filter aid, filtration rate, and turbidity, filter runs

ranged from 10 min. to 30 days. Aus Gres reported usual runs of 1 week, Linwood of 16 days, and Saginaw Township of ½ to 1 day. No cost-of-filtration data were available at any of the plants.

Three additional lake water plants in New York were inspected at Tupper Lake, Palmyra, and Lyndonville. Tupper Lake is a mountain lake about 2 miles wide by 8 miles long, and is fed by springs and melting spring snows. In winter, the lake turbidity is usually less than 2 ppm, but it increases in the spring to as much as 60 ppm. During the summer when it is used only as an emergency water supply, the maximum turbidity is 30 ppm. With water of this turbidity, filter runs vary from 50 to 87 hr at a filtration rate of 1.25 gpm per square foot. The operator and town officials reported excellent removal of turbidity by the plant but only partial removal of color.

TABLE 4

Location of Diatomite Municipal Plants

States Having Approved Plants	No. of Plants
Illinois	2*
Michigan	8
New Mexico	1
New York	10
Oregon	2†
Alaska	1†
States Having Plants Not Approved	**No. of Plants**
California	1*
Minnesota	1‡
Oklahoma	1†
Pennsylvania	1*
Virginia	1§

* Plants abandoned.
† Experimental plants.
‡ Plant serving industry only.
§ Plant approved with chlorination only.

Palmyra takes its water from Canandaigua Lake, one of the Finger Lakes in central New York. The lake is about 15 miles long by 2 miles wide. The turbidity in the lake is usually very low, except during spring runoff. Lyndonville takes its water from Lake Ontario, which also has low turbidity in the water. Both cities report excellent removal of turbidity. Neither plant had operating data available.

The experience at the seven plants in Michigan and three plants in New York indicates that diatomite filters can be used successfully and economically on lake waters containing up to 80 ppm of turbidity. *None* of the plants demonstrated an ability to operate filters in their most efficient range.

Impounding Reservoirs

Cherry Valley and Gasport, N.Y., obtain water from small impounding reservoirs. Cherry Valley has a reservoir of 2–3 acres fed by springs and surface runoff. Gasport has a reservoir 9–10 mil gal in capacity, also fed by runoff. The turbidity at both plants varies from a trace to as much as 60 ppm. Both plants report excellent removal of turbidity. Cherry Valley maintains complete records to show costs of water filtration.

Impounded River

Belleville, Mich., obtains its water from the Huron River above a small power dam. The water is used as a summer emergency supply. The city has no record of the water turbidity, but the operator classes it as very high. In spite of the high turbidity, filter runs of 8 hr are reported with excellent turbidity removal. The plant operates only 8 hr per day.

Abandoned Plant

In addition to the summer 1956 visits of fourteen municipal plants still in service, the author has studied one municipal plant which has since been abandoned. In 1950 a study was made of the diatomite filtration plant built at Mounds, Ill., for the removal of iron from a well supply. The raw water was obtained from wells containing 0.56 and 1.85 ppm of iron, respectively. The water was aerated on a coke tray aerator and settled in a 40,000-gal ground storage reservoir. The water was filtered at a rate of 300–425 gpm. Two filters were provided with sufficient filter area to give a design filtration rate of 1.88 gpm per square foot. The removal of iron by the plant was excellent; filtered samples sent to the state for analysis consistently showed less than 0.01 ppm of iron.

The wire-wrapped filter elements in the plant were difficult to keep clean and free of iron. Filter runs prior to the inspection averaged about 10–12 hr. At the time of the visit, the plant operator and the mayor expressed dissatisfaction with the plant and indicated that they hoped to abandon it because of the operating difficulties.

The real source of the operating difficulties may be found in the operating practices employed at the plant. These may be summarized as follows:

1. Although two filters were provided, only one filter was operated at a time, resulting in an operating filtration rate twice the design rate. The actual filtration rate at the start of a run was about 3.91 gpm per square foot and the filter was backwashed when the rate dropped to 1.88 gpm per square foot. The average filtration rate was thus about 2.90 gpm per square foot.

2. Although flow rate indicators were provided, no attempts were made to secure a constant rate-of-flow through the filters.

3. In precoating, the filter-aid precoat was run on and filtration started at once. The excess filter aid passing the filter was allowed to enter the distribution system.

4. The service pumps supplying the filtration pressure were controlled by the water level in the elevated tank. When the pumps were off, the iron-

TABLE 5

Sources of Water Supply for Diatomite Filter Plants

For Removal of	Source of Water	No. of Plants
Iron	wells	2*
Iron	abandoned coal mine	1
Iron	impounded brook & auxiliary well	1
Turbidity and algae	Midland–Saginaw pipeline	7
Turbidity and algae	Catskill Aqueduct	1
Turbidity and algae	lakes	7
Turbidity and algae	rivers	6†
Turbidity and algae	impounding reservoirs	2
Turbidity and algae	creek	1
Taste	well	1*

* Plant abandoned.
† One plant abandoned.

contaminated filter cake was allowed to drop off and was sometimes picked up again when the filtration was resumed on demand of the elevated tank water level.

5. When the plant ran out of filter aid, as it had done for a 2-week period during which the inspection was made, the iron-bearing water was run through the plant sometimes *without bypassing* the filters.

Under such conditions a diatomite filter could not be expected to operate satisfactorily. The failure of the installation should be considered a human failure in not understanding the principles of diatomite filtration, rather than a mechanical failure of the filters themselves.

Physical Installations

All of the plants visited recently used installations basically similar. All but two used vertical, cylindrical, filter elements suspended from a tube sheet. The filtration rates varied from 0.9 to 2.0 gpm per square foot. Most used precoat pots and body–feed tanks. Body feed was mixed with flash agitators and fed through proportioning pumps. Figures 1, 2, and 3 show views of a typical installation.

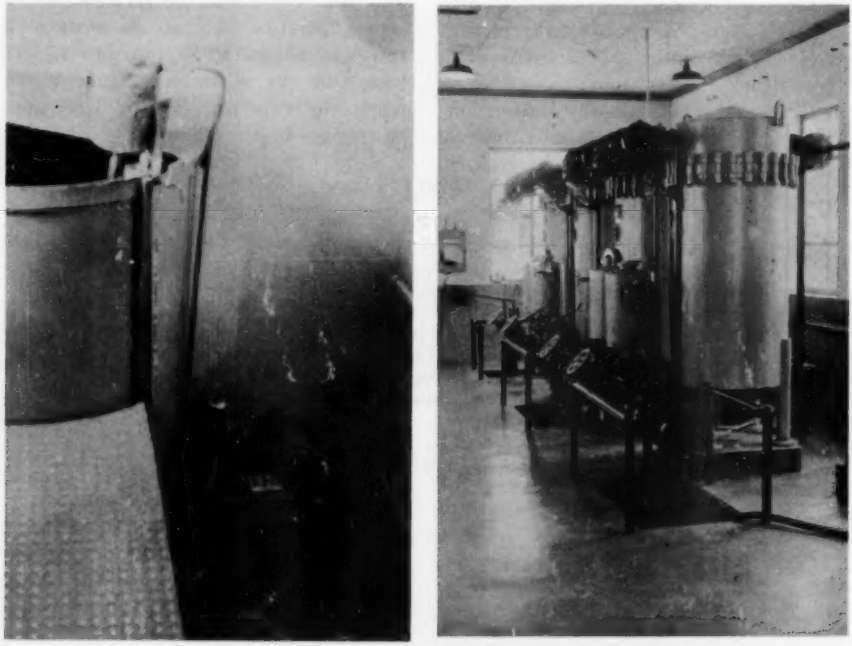

Fig. 1. Municipal Diatomite Filtration Plant, Palmyra, N.Y.

Vertical diatomite filters are shown on the left. On the right is a typical body-feed tank, proportioning pump, and flash mixer.

Certain recommendations and warnings relating to operations and brought out as a result of the visits, must be given: [1] Plug valves give trouble in maintenance and operating when body feed must pass through the valve; [2] according to the operators, stone elements require more frequent cleaning and replacement than other types of filters should have facilities for removing the heads without the use of overhead cranes or A frames; [7] the filter elements should be independently removable from the tube sheet; [8] the plant layout should be practical and designed for convenience of operation; [9] reciprocating service pumps should not be used with diatomite filters; and

TABLE 6

Typical Average Daily Use of Materials, Cherry Valley Diatomite Filter Plant

Month	Water Produced *gpd*	Precoat *lb*	Body feed *lb*	Chlorine *lb*	Power *Kwhr*
Feb. 1955	309,000	19	60	2.0*	187
May 1955	173,000	11	54	1.5	110
Sep. 1955	100,000	7	33	2.2	110
Dec. 1955	258,000	6	43	1.38	180
Feb. 1956	312,600	7	39	1.50	205

* Estimated.

TABLE 7

Cost of Materials, Cherry Valley Diatomite Filter Plant

Month	Cost per 1,000 gal—$					
	Filter Aid*	Chlorine†	Power‡	Labor§	Total	Per 1,000 gal‖
Feb. 1955	4.74	0.30	3.82	2.50	11.36	0.037
May 1955	3.90	0.225	2.24	2.50	8.87	0.051
Sep. 1955	2.40	0.33	2.24	2.50	7.47	0.047
Dec. 1955	2.94	0.21	3.68	2.50	9.33	0.036
Feb. 1956	2.76	0.22	4.19	2.50	9.67	0.031

* $120 per ton.
† 15¢ per pound.
‡ 2.04¢ per kilowatt hour.
§ $1.25 per trip to plant—two trips per day.
‖ Total average is $0.040 per 1,000 gal; add $0.02 depreciation costs for a total filtration cost of $0.06 per 1,000 gal.

elements; [3] the body-feed proportioning pumps do not have sufficient capacity to be effective in periods of high turbidity—with high strength slurries, maintenance becomes a problem and operation becomes erratic; [4] there is a definite need for better flow-rate indication and control; [5] the system of pipes should permit backwashing with filtered water; [6] the [10] prechlorination of raw water should be required in municipal filtration plants.

Operational Procedures

All of the municipal plants used basically the same method of operation. The filters were normally operated to about the recommended pressure drop if runs were long. The use of body

feed was generally ignored or ineffectually used. At some plants, the body-feed apparatus was in storage. In all plants there was little variation in the amount of body feed used. When, as it happened in some plants, the turbidity increased 30-fold, the body feed might be doubled or, at most, quadrupled. At no plant, the author thinks, was body feed used effectively.

The major recommendations pertaining to plant design from the point of view of operation are that: [1] body-feed equipment should be both large and versatile enough to provide continuous body-feed dosage for an 8-hr period at the maximum rate required; [2] body-feed rate should be based on a need of not less than 2–3 ppm of body feed per ppm of turbidity (this is an approximate recommendation as turbidity is a poor indication of body-feed requirements [*4, 5, 9*]); [3] the operator should anticipate and make body feed adjustments consistent with changes in the water quality; and [4] flash mixers should not be used in body-feed tanks, as they tend to break down the fragile filter-aid particles.

Operating Records

Of the plants visited, only one maintained records of sufficient accuracy and length to permit cost of filtration evaluation. No plant maintained any record of raw- or filtered-water turbidity. The records at Cherry Valley most nearly approached the desired minimum records.

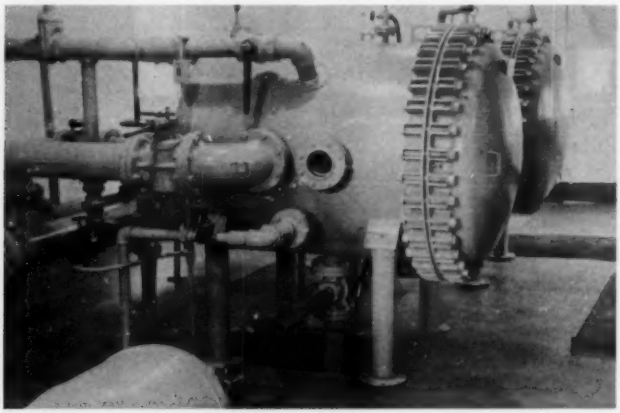

Fig. 2. Horizontal Diatomite Filter, Palmyra, N.Y.

Table 6 lists the Cherry Valley average daily use of materials in the operation of its filter.

Town officials indicated that filtration costs were excessive, for water charges were 60¢ per 1,000 gal, yet the department was losing money each year. Analysis of the filtration data revealed that the cost of filtration averaged only about 4¢ per 1,000 gal. The breakdown is given in Table 7. Assured that this represented a very economical cost of filtration, the record analysis was continued. Plant production averaged 242,500 gpd against

plant sales of only 37,000–40,000 gpd. Operating losses of 85 per cent obviously resulted from plant waste, and not from high cost of filtration. In spite of the fact that more than 6 years of records were available in Cherry Valley, the city fathers were unaware of the fact that they were wasting more than 85 per cent of the water filtered.

On the basis of this inspection trip, it is recommended that: [1] a minimum standard record of filter plant operation be established and maintained at every plant; [2] every plant should also maintain a record of water quality—samples of raw and filtered water should be taken and sent to the state health department for chemical and bacteriological analysis weekly and state reports should be retained by the city; [3] a record of water turbidity is the minimum essential for use in controlling body-feed operations, but turbidity is not a good measure of body-feed requirements.

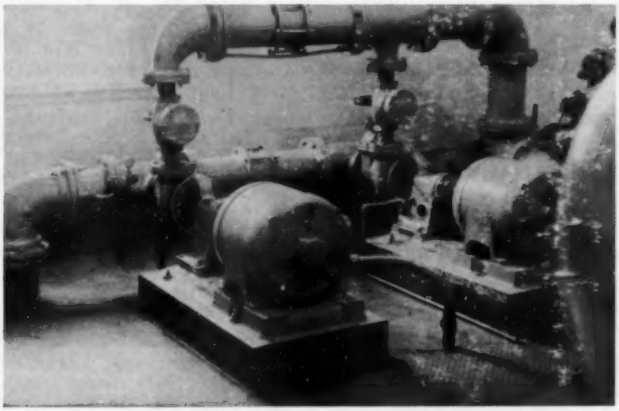

Fig. 3. Pumping Units, Diatomite Filtration Plant.

Operator Requirements

Both Michigan and New York require that the operator of a diatomite filtration plant be registered. A minimum requirement for registration should include a high school education, mechanical ability, demonstrated knowledge of the principles of water treatment and diatomite filtration, attendance at a short course or other training program, demonstrated interest in economical plant operation, and ability to maintain adequate records. Probably the most important deficiencies of the operators questioned were their lack of understanding of the principles of body feed and their lack of interest in maintaining adequate plant records.

Conclusions

The results of the survey questionnaire and the inspection of sixteen municipal diatomite plants indicated conclusively that:

1. Diatomite filtration plants can be and are being operated successfully and

economically on potable water supplies for municipalities. Successful municipal filtration plants deriving their water supply from lakes, impounding surface reservoirs, and large rivers were inspected.

2. A study of plant operation indicated that the effectiveness of filtration and economy at all of the plants could be improved by the better application of the principles of body feed.

3. The only cost data available indicate that, at Cherry Valley, N.Y., the cost of filtering impounded surface water with a turbidity of up to 60 ppm, averaged 6¢ per 1,000 gal including labor, power, diatomite, and plant depreciation. Operating costs excluding plant depreciation were about 4¢ per 1,000 gal.

4. To provide cost and filter efficiency data for additional plants, controlled field tests should be made at existing municipal plants suitable for research.

5. A detailed review dealing with items to be considered in the review of plans and specifications for diatomite filters for municipal installations should be prepared and distributed to improve the design of future municipal plants.

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Environmental Radiological Monitoring

Harry N. Lowe Jr., and Don C. Lindsten

A paper presented on Oct. 25, 1956, at the Chesapeake Section Meeting, Baltimore, Md., by Harry N. Lowe Jr., and Don C. Lindsten, both of the San. Eng. Branch, Engr. Research & Development Labs., Army Corps of Engrs., Fort Belvoir, Va.

SANITARY engineers and others associated with the general field of public health should be aware of the possible impact which released atomic energy might have upon the health and well being of all mankind.

A potential source of radiological contamination of the environment comes from the nuclear power reactor. To reap the full benefits of nuclear power, reactors should be safe and their operation should be monitored in sufficient detail to make sure that the margin of safety remains. A major failure occurring in an operating reactor is easy to spot. The task of monitoring equipment and techniques is to detect and measure long-term additions to the environmental radiological background. As nuclear power plants use water and could contaminate surface streams, environmental monitoring is of interest to both the nuclear power specialist and those associated with water works engineering.

The US Army Corps of Engineers and the AEC are constructing the prototype of the Army Package Power Reactor (APPR–1) at Fort Belvoir, Va. This reactor is a pressurized water power unit rated at 2,000 kw. Built near the Potomac, the plant will draw water from Gunston Cove for condenser cooling.

In designing and planning plant operation, no efforts were spared to assure a safe reactor. The Sanitary Engineering Branch, Engineer Research and Development Laboratories, Fort Belvoir, Va., is determining the radioactive background in the vicinity of the site and will monitor the area once the reactor is in operation. The work is being done under the general supervision of the Nuclear Power Branch of the Laboratories.

Need and Effectiveness

Power reactors will normally be equipped with instruments capable of detecting any significant contaminating event. The basic problem of environmental monitoring is, therefore, the detection and measurement of small increases in background that might occur after the plant has become operational. The changes which may have to be measured will occur over long periods of time, thus placing a premium on accurate and lengthy records.

It must be understood that no site on earth has a radioactive background of zero. The planet is continually subjected to ionizing radiation from cosmic rays, terrestrial radioactive materials such as radium, thorium, or uranium ores, and gaseous radioactive

materials such as radon or radioargon. The normal background, however, although finite, is usually of a low order of magnitude. The Washington, D.C.–Fort Belvoir–Baltimore triangle falls in this normal pattern.

Although little information is available on natural backgrounds in past years, it may be assumed that the background at any given site was essentially constant prior to 1945. Today, background measurements are subject to wide variations, resulting principally from nuclear weapons and devices tests of the US, the United Kingdom, and the USSR governments. Other contributors to the contamination may be universities, hospitals, or other research organizations using radioactive materials or nuclear reactors.

To be effective, a monitoring program must be able to detect and measure small increases in the radioactivity level due to local causes and, at the same time, recognize and reject those increases resulting from bomb debris fallout and other remote causes. It is thus necessary to measure background for some time before the reactor is operated. A year seems to be about the optimum period. A sudden rise in the radioactive count of a nuclear power plant cooling water could, for example, caused by bomb debris fallout at a remote test site rather than failure or faulty operation of the reactor. In practice, the monitoring program must maintain a continuous check of radioactivity in the air, in surface water, in silt that settles out of surface water, and in local ground water.

Monitoring Methods Used

The environmental radiological monitoring program at Fort Belvoir provides for the collection and study of the following samples:

TABLE 1

Range and Average in Radiological Background *

Sample	Background	
	Range—*Counts per minute*	Average—*Counts per minute*
Ground water	0–7.5 per liter	2.1 per liter
Precipitation	9–363 per liter	93 per liter
Air	1.7–9.3 per 1,000 cu ft	5.2 per 1,000 cu ft
River bottom sediment	0–6.7 per gram	3.4 per gram
Surface water	0–18.7 per liter	2.9 per liter
Dust collected on gummed paper	0–450 per square foot	60 per square foot

* Recorded at Fort Belvoir, Va., Nov. 1955–Apr. 1956.

1. *Ground Water*—collected weekly from a test well adjacent to the reactor site

2. *Precipitation*—collected at the site as rain and snow occurs

3. *Air*—collected at two air sampling stations at Fort Belvoir (stations operated 1 day per week)

4. *River Sediment*—collected once every three months at sampling points in the Potomac River and tributaries

5. *Surface Water*—collected once weekly at sampling points in the Potomac River and tributaries (sampling includes raw water to Dalecarlia Filtration Plant, Washington, D.C.)

6. *Dust (Gummed Paper)*—collected once weekly at sampling stations in the Fort Belvoir–Washington, D.C. area.

After preparation, all samples are counted with a Geiger-Müller end window tube assembly and scaler. The next step is to evaporate 1 lb of the sample to near-dryness in an evaporating dish. The residue is then transferred to a planchet and evaporated to dryness under an infrared lamp. The final step is to count the sample and report results in counts per minute per liter. Air filtration and gummed paper samples are handled in much the same method. The sample is turned to ash at 600°C, then transferred to a planchet. Finally, the count sample is made. Air filtration results are reported in counts per minute per 1,000 cu ft of air samples; gummed paper samples as counts per minute per square foot of gummed surface exposed.

River bottom sediment samples are dried at 150°C. A 1-g sample is then weighed out and counted. The results are reported in counts per minute per gram.

The current program is providing data before the reactor is placed in operation. A slightly modified version of this program will be used to provide a continuous check on the environmental radiation level after the reactor is placed in operation.

Typical Results

Typical results of the monitoring program are shown in Table 1. The fluctuation in background is due in large measure to fallout from the scores of nuclear explosions that have taken place since 1945. Occasionally a radioactive cloud from a nuclear detonation may pass over any site with an accompanying temporary rise in the level of radioactivity. Such an event took place the weekend of Apr. 16–17, 1955, following the detonation of an atomic device at the Nevada Proving Grounds on Friday, Apr. 15, 1955. The radioactive cloud passed over the Washington, D.C., area concurrent with rainclouds and limited rainfall. Rain samples showed a count of 39,200 counts per minute per liter. This count emphasizes the importance of establishing current variations in background in order to evaluate properly apparent indications of local contaminating events. The monitoring program described has detected and measured every significant change in the radiological background since it began in November 1955. The procedures are equally applicable to the task of monitoring raw water supplies and effluent at water treating plants. When a general purpose laboratory already exists, the total capital outlay for a modest program of environmental monitoring is less than $2,000.

Discussion

John W. Krasauskas

Chief, Plant Operation Branch, Water Supply Div., US Army Corps of Engrs., Washington District, Washington, D.C.

In this presentation, the authors have treated the application of the principles of radiological health monitoring to the safe operation of a package nuclear reactor. This is a limited application of environmental radiation monitoring since it is essentially a safety control measure of a manufacturing process.

The scope of the water works operator is also restricted to that aspect of radiological health called environmental sanitation where it is ascertained that liquid, solid, and gaseous radioactive wastes do not exceed permissible tolerance levels. The increased use of radioisotopes in industry and research has resulted in substantial increases in the amount of radiation in the environment. It is obvious also that the use of the atom will continue to develop, thus complicating the problem even more. As long ago as 1952, a survey showed that more than 41 per cent of radioisotope users disposed of their wastes by dilution and discharge to sewers. Since radioactivity cannot be destroyed by any means known today, and many chemicals have long half-lives, this pollution passes sewage treatment plant processes practically unaltered and enters streams used as sources of water supply.

The water works profession, having no control over the amount or time of disposal of radioactive wastes, must depend on frequent monitoring to ascertain whether maximum permissible concentration values are exceeded, and the hazard must be assessed.

It is therefore important that responsible personnel have at least a working knowledge of safe-tolerance levels, the terminology, and the use and limitations of various detection devices.

The fundamentals of radiation require only a minimum of mathematics, physics, and chemistry; short orientation courses are available at certain universities, at Oak Ridge, Tenn., and at The Robert A. Taft Sanitary Engineering Center, Cincinnati, Ohio.

That the water works profession is slow in acquiring this knowledge was brought into sharp focus by a recent AWWA Task Group which reported that only eleven state and territorial laboratories have trained personnel and adequate equipment for the measurement of low-level water contamination. Nineteen water facilities owned some type of radiation detection device; eleven of these had survey meters, and only four had continuous monitoring equipment.

Cost may be a factor deterring many facilities from participation in a monitoring program. Precise, low-level counting is expensive; equipment may cost up to $1,500. Emergency tolerance levels, however, can be monitored with survey meters costing only $140–$280. A simple procedure outlined in Federal Civil Defense Administration Bulletin can be followed (*1*).

Continuous monitoring of water is justified only in critical areas or as a civil defense measure because it is both expensive and not sensitive enough for low-level recording. AWWA Task Group 2630–P indicated that the sensitivity of continuous monitoring installation lay between the survey meter and the proportional counter. Hazardous concentrations could pass by unnoticed, thus making it necessary to collect occasional samples to be subjected to analysis by more sensitive instruments.

The stress that the authors placed on the establishment of accurate and lengthy records of background radioactivity before a monitoring program is established on a routine basis has merit. Without these base records, it is difficult to recognize and assess the amount of radiation present.

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Specialty Board Certification for Sanitary Engineers

John E. Kiker Jr.

A paper presented on Nov. 13, 1956, at the Florida Section Meeting, Daytona Beach, Fla., by John E. Kiker Jr., Prof. of Civ. Eng., Univ. of Florida, Gainesville, Fla.

IN 1952, two alert sanitary engineers initiated a movement to create a strong organization dedicated to the singular goal of strengthening the sanitary engineering profession. The movement was started by Rolf Eliassen, Professor of Sanitary Engineering, Massachusetts Institute of Technology, in collaboration with Harvey F. Ludwig, chief of the Sanitary Engineering Resources Program of the US Public Health Service. They prepared three drafts of a "Proposal to Establish an American Institute of Sanitary Engineers" and were enthusiastically joined by others including Alvin F. Meyer, Deputy for Environmental Engineering, US Air Force, and the author. These four became the first temporary officers of the organization, with Rolf Eliassen as president, the author as vice-president, Harvey F. Ludwig as secretary, and Alvin Meyer as treasurer.

At least 600 copies of the third draft of the proposal were mailed to prominent sanitary engineers throughout the country, and a fourth draft of the proposal incorporated as many as possible of the suggestions that were received. Among the suggestions was one to change the word "Institute" to "Academy." This change was made and the American Academy of Sanitary Engineers was incorporated in March 1953. The incorporators were the four persons named above and Allen D. Brandt, chief industrial hygiene engineer of the Bethlehem Steel Company.

In the meantime, the ASCE Committee for the Advancement of Sanitary Engineering became interested in the movement and began exploring the possibilities of developing procedures for a more unified approach to the problems that had been visualized. Under the sponsorship of the ASCE a new Joint Committee for the Advancement of Sanitary Engineering was formed. This committee originally consisted of three representatives each from the ASCE, the AWWA, the FSIWA, the APHA, and the American Society for Engineering Education. As a result of the interest shown by this committee, representatives of the academy agreed to postpone further action until the committee had an opportunity to complete studies of its own and to make its own recommendations as to how the objectives of the academy might best be accomplished.

Under the chairmanship of Earnest Boyce, the joint committee polled its members to determine their reaction to the formation of the proposed new organization. Of the fifteen members on the committee, nine were initially opposed to action, three were neutral, and only three were definitely in favor

of the organization. It may be of interest to compare this to an initial poll by Rolf Eliassen. Of 84 replies, 57 were in favor, nine were neutral, and only eighteen were opposed. Other polls, including replies received by the writer from many Florida engineers, were overwhelmingly in favor of action. Erman Pearson, Associate Professor of Sanitary Engineering at the University of California, observed that support for the new organization came generally from persons less than 40 years of age and opposition from those over 40.

Initial Meeting

In any event, the joint committee took cognizance of the predominantly favorable reactions and held a very successful first meeting on July 27–28, 1953, in Washington, D.C. The committee recommended that the ASCE Sanitary Engineering Division sponsor a specialty board certification program, with the idea that the sponsorship would be transferred ultimately to the Engineers Joint Council if this should be found feasible. Objectives of the specialty board, as recommended by the committee, were: [1] the promotion of unity in the profession of sanitary engineering; [2] the promotion of specialty board certification of applicants who qualify; and, [3] the promotion of the sanitary engineering profession in its dedicated fields of activity and responsibility.

It was also recommended that the American Institute of Chemical Engineers and the American Society of Mechanical Engineers be invited to nominate members for service on the joint committee. During this, and subsequent meetings of the committee, many other recommendations were made and important actions were taken. Many details had to be worked out. Only the most important can be mentioned here, but acknowledgement should be made of the fact that the solutions proposed by the joint committee are believed superior to the plan initially proposed by the group that started the movement. A major accomplishment by the committee was that of eliminating the necessity of forming an organization competing with any of those now in existence. The opposite has happened and the developments are being supported by existing organizations, to the profit of sanitary engineers all over the country. The organization started by the small group mentioned previously was dissolved when it was found that there was no further need for it; and the treasury, containing donations of interested persons, was turned over to the newly constituted group.

Intersociety Board

The joint committee has met about twice a year since its first meeting in the summer of 1953. It developed articles of incorporation and by-laws of an American Sanitary Engineering Intersociety Board which was incorporated on Oct. 21, 1955. The intersociety board is presently administered by a board of trustees consisting of eighteen members, three from each of five original sponsoring organizations, and three trustees at large, elected by the board.

The by-laws and the certificate of incorporation are published in a Bulletin of the American Sanitary Engineering Intersociety Board.* Extracts from these by-laws are to be found in an appendix to this article.

* Obtainable on request from the Office of the Secretary, 35 W. 39th Street, New York 18, N.Y. Applications for certification may also be obtained there.

The nature of the business of the corporation and the major objects and purposes to be promoted or carried on by it are as follows:

1. To improve the practice, elevate the standards and advance the cause of sanitary engineering

2. To grant and issue to engineers duly licensed by law to practice engineering, certificates of special knowledge of sanitary engineering or in any field thereof, and to revoke certificates so granted or issued

3. To receive and act upon applications for such certificates . . . , to determine, by examination, investigation or otherwise, the fitness of applicants for, and the holders of, such certificates

4. To furnish to the public, or to interested organizations, lists of engineers having special knowledge in sanitary engineering, as evidenced by certificates granted by the corportion

5. To keep and maintain a register of holders of certificates granted by the corporation, such roster to be known as the American Academy of Sanitary Engineers.

Need for Certification

The formation of the American Sanitary Engineering Intersociety Board and its specialty board certification program is a milestone in engineering history. It represents the first program in this country for specialty engineering certification beyond state registration requirements. Similar certification programs have already proved of value in enhancing the recognition and prestige of the medical profession, and there is every reason to believe that the engineering profession in general, and the sanitary engineering profession in particular, should be strengthened by the certification of its qualified representatives.

Over 200 applications for certification of sanitary engineers were reviewed at a board meeting in Pittsburgh on Oct. 18, 1956, and about 150 were approved. The number of applications exceeded expectations because the movement has not as yet been given widespread publicity and many qualified sanitary engineers have not been made aware of its importance. By the end of 1956, however, the number of applications for certification from qualified sanitary engineers exceeded the number of qualified physicians that have been certified either in preventive medicine and public health, or in plastic surgery, and may ultimately reach the number that are certified in general surgery. Considering the success which has been experienced by the Boards—such as the American Board of Pediatrics which are made up of the limited numbers of persons certified in eighteen different fields of medicine, there should be little question that the specialty board certification for sanitary engineers should also be successful.

In determining the areas of sanitary engineering specialization to be recognized, the American Sanitary Engineering Intersociety Board attempted to include all of the activities covered in the definition of the term "sanitary engineer" by the Committee on Sanitary Engineering and Environment of the National Academy of Sciences, National Research Council. At present, five areas of specialization are recognized. These are: [1] water supply and waste water disposal; [2] public health engineering; [3] industrial hygiene; [4] radiation hygiene and hazard control; and, [5] air pollution control.

Persons may be certified in any one of these fields, and the examination leading to certification of any individual will be designed to test his knowledge and ability in the field in which he claims special proficiency. It is not anticipated that anyone will be examined or furnished certificates in more than two fields.

As regards certification without examination, the by-laws of the intersociety board state that registered professional engineers who have a minimum of 15 years of practice *and have achieved a high standing in sanitary engineering* may be excused from examination. Application must be made on the prescribed form before Jul. 1, 1957, and the full application, examination, and annual fees must be paid, even though the examination is waived.

The secretary's office advises that there will be no need to mark an application specifically for consideration of certification without examination. Each application received before Jul. 1, 1957, will be considered in the light of the above provisions. If the candidate is deemed eligible for certification without examination, he will be so notified. If, on the other hand, he does not meet the special requirements, he will be notified of his admission to examination, or his rejection, whichever applies.

Value of Certification

As regards the requirements for certification, it is inevitable that the board must make delicate decisions on some borderline cases. While a majority of applications and eligibility investigations permit clear-cut decisions, questions as to whether an applicant "has achieved a high standing in sanitary engineering" are not always easily answered. Favorable consideration of an application is usually facilitated when an applicant lists, in the spaces provided for this purpose, a reasonable amount of professional activity as manifested by his membership in scientific or technical societies or associations, and particularly by his professional publications or by his list of special honors, awards, and offices held in professional societies. The nature of his experience is also important. Fifteen years of progressively responsible experience following graduation from college will usually entitle a person to certification without examination. But 1 year of ordinary experience repeated eight, fifteen or even 30 times, may not be enough to admit a person to an examination for certification.

On the other hand, it should be pointed out that a person who is not in a responsible position should not be affected adversely by the certification program. They will not generally need to become certified. After all, no certificate granted or issued by the board will confer any legal qualification or privilege to practice sanitary engineering, any more than a certificate from a medical specialty board will confer a legal qualification or privilege to practice medicine. The only legal requirement for practicing engineering in any form, is still a registration certificate or license issued by a state board of engineer examiners.

Many sanitary engineers are probably debating the value of applying for certification at this time, rather than waiting for further developments. For those who obviously cannot as yet meet the requirements for certification, little can be lost by waiting. To those who, on the other hand, can meet the requirements, and particularly anyone who may qualify for certification with-

out examination there is real advantage in applying early. It is suggested that their decision should be influenced by the history of engineering registration.

When the first engineering registration laws went into effect, relatively few people realized that registration would become as important as it is today. Fewer still took advantage of the privilege of obtaining registration without examination. Yet all 48 states now have registration laws, and many who at one time could have registered without examination, can no longer do so. Furthermore, many who at one time could have passed a registration examination can do so no longer. Many who can no longer meet the requirements now wish they had registered when they had the opportunity. Several sanitary engineers who are in this category have applied for certification. Typical of their explanations was that of one prominent person who indicated that he was never in a position which actually required registration, that consequently he had never gone to the trouble of applying for registration, and that his present situation is such that he no longer has the opportunity. Cases of this kind are somewhat pitiful. And one of the ironies of the situation is that among the engineers who should gain much from the certification program—those employed by the federal government—are the very ones for whom the incentive to become registered has been most limited.

APPENDIX

Extracts From By-Laws of the American Sanitary Engineering Intersociety Board, Inc.

Art. III—Board of Trustees

Sec. 9—*Committees:* The Sanitary Engineering Specialty Committee, which shall consist of not less than three members of the Board of Trustees and not more than three persons not members of the Board of Trustees who shall be selected on the basis of special qualifications, nominated by the chairman, and elected by a majority of the board, and which shall formulate and recommend to the board from time to time standards of competence to be met by applicants for certificates of special knowledge in each or any field of sanitary engineering, and shall prescribe the form and contents of applications for such certificates, investigate and report upon the eligibility of applicants for such certificates, conduct and evaluate the results of examinations of such applicants, and make reports and recommendations to the board with respect to the granting and issuance of such certificates to the applicants therefor. . . . The Sanitary Engineering Specialty Committee shall represent the board in all matters relating to examination of applicants for certificates and in recommending certification, but such committee shall not have power to grant or issue any such certificate.

Art. IV—Officers

Sec. 11—*Consultants:* The board may utilize or employ such consultants for itself or for its Sanitary Engineering Specialty Committee as it shall deem necessary in order to establish the standards of proficiency required, and to conduct examinations to determine the fitness for certification in the field of sanitary engineering or any subdivision thereof. Such consultants shall be outstanding in the field or fields in which they are utilized. . . .

Art. VI—Certificates of Special Knowledge in Sanitary Engineering

Sec. 1—*Procedure:*

1. *Applications:* Applications for certificates must be made on the prescribed form, which must be wholly completed and documented. . . . The completed application must be filed with the board not less than 120 days prior to the date of the examination.

2. *Application and examination fees:* The fee for making the application shall be $10 which must accompany the application and is not refundable. The fee for the examination shall be $25, which must be paid on acceptance by the specialty committee of the application, and not less than 60 days prior to the examination. Applicants who are accepted for examination by the board, but who fail to appear, will be considered for examination under the provisions of Par. 3 below. The examination fee will not be refundable, but in case the applicant fails to appear for the examination, or fails in the examination, an additional examination fee will not be charged for said initial reexamination, or initial examination in the case of an applicant who fails to appear for his first examination.

3. *Reexamination:* Reexamination will be granted to candidates failing the first examination. Such reexamination (or, in the case of an applicant failing to appear for the initial examination) shall be held within a period of 18 months following the first or initial examination. The board, as it deems necessary, may or may not require the filing of another application (for which there shall be no additional charge). If the applicant fails the second examination, he may take a third examination, without any additional charge, provided the specialty committee approves this third examination; and further provided that a period of at least 12 months has elapsed since the second failure.

4. *Annual fees:* Applicants who are certified under Sec. 4 and Sec. 5 of Art. VI of these by-laws shall pay an annual renewal fee of $5.

Sec. 2—*Requirements:* Requirements for eligibility for examination shall be both general and special in nature.

1. *General requirements:*

a. The applicant shall be of good moral character and of high ethical and professional standing.

b. The applicant must be a graduate of a college acceptable to the board, and must possess a degree in engineering or its educational equivalent, which, when combined with his experience in his chosen field of work, shall be acceptable to the board; and he must meet the definition of sanitary engineer approved and adopted by the American Sanitary Engineering Intersociety Board, Incorporated.

c. He must have a license to practice engineering.

d. He must have had at least 8 years of engineering experience in one or more phases of sanitary engineering following graduation from college.

2. *Special requirements:* The applicant must have had at least 4 years of responsible charge of work in sanitary engineering, which work must include active participation in responsible design, management, research, administration, or teaching with responsibility primarily in the field of sanitary engineering in an educational institution of recognized standing.

Sec. 3—*Examination and reexamination:* Examinations will be held from time to time and in such places as are indicated by the number of applications received and determined by the specialty committee. As far as possible, geographical locations will be selected so as to minimize travel on the part of all concerned.

The examination will consist of three parts:

a. A written examination covering the knowledge of the applicant in the broad field of sanitary engineering, including the principles of public health and their application.

b. A written examination designed to test the knowledge and ability of the ap-

plicant in the field in which he claims special proficiency.

c. Appearance before the Sanitary Engineering Specialty Committee or its representative or representatives, with an accompanying oral test to develop fully and satisfactorily the qualifications of the applicant. This oral test will ordinarily be held at the time of the completion of the written examination and special endeavors will be made to adapt the questions to the applicant's specific experience and work.

Where possible, reexaminations will be scheduled to coincide with normally planned examinations and procedures will be similar in all cases.

Sec. 4—*Certification:* Upon satisfactory completion of the examination and upon recommendation by the Sanitary Engineering Specialty Committee that the applicant meets the prescribed standards, the board will issue a suitable certificate. This certificate, which will be signed by the officers of the board and will have the seal of the board affixed, remains the property of the board, but the person to whom it is issued is entitled to its possession unless and until it is revoked. A certificate may be revoked at any time for evidence of fraud or dishonesty, misrepresentation or concealment of facts in the application; or for the revocation of the engineering license to him or for the failure to pay the annual renewal fee.

Sec. 5—*Certification without examination:* Registered professional engineers who have had a minimum of 15 years of practice and have achieved a high standing in sanitary engineering may be excused from examination. For this certification without examination, application must be made on the prescribed form before Jul. 1, 1957, and the full application, examination, and annual fees must be paid, even though the examination is waived. Applicants under this category may be accepted by the board, in its judgment, whether or not they meet fully the eligibility and educational requirements previously listed.

Art. VIII—American Academy of Sanitary Engineers

The applicant upon certification becomes a member of the American Academy of Sanitary Engineers and is entitled to have his name carried on the roster of the academy, which roster shall be maintained by the American Sanitary Engineering Intersociety Board and shall be revised at least annually to include the members who are in good standing.

Repair of Spillway Leaks at New Croton, N.Y.

Arthur C. Ford

A contribution to the Journal by Arthur C. Ford, Comr., Dept. of Water Supply, Gas & Electricity, New York, N.Y.

TO those entrusted with the security of water supply structures, no emergency is more disturbing than water escaping in significant amounts through a reputedly watertight structure. This is particularly true of a structure as important as a dam impounding the contents of a large reservoir upon which a metropolis depends for its water supply.

Aside from considerations of safety, and unless ample alternate supplies are available, the prospect of a lengthy shutdown for repairs poses problems in connection with continuation of service.

Near the end of July 1956, notification was received by the chief engineer of water supply and the Commissioner of the Department of Water Supply, Gas & Electricity of the city of New York, that thin sheets and spouts of water were discharging downstream through a pattern of cracks and open mortar joints in the granite block face of the spillway section of the New Croton Dam. A rough measurement indicated a 1½–2-mgd waste. This observation became possible only when wasting over the spillway stopped. The wasting had been almost continuous since the unprecented October 1955 storm.

Original Construction

The report of the Aqueduct Commission, 1895–1907, describes the construction of the New Croton Dam and spillway. The structure, built across the Croton Gorge about 3 miles above the confluence of the Croton and Hudson rivers, is 2,168 ft long, of which 1,000 ft is spillway. The spillway structure lies generally to the north of the main dam, joining it at approximately right angles through a curved section forming an elbow (Fig. 1). With the exception of a 128-ft earth-filled section with masonry core, the entire dam is of continuous masonry construction without expansion joints.

The elevation of the spillway, prior to the modification presently underway, was at el 200, Croton datum. Wooden flashboards added in 1907 raised the level to el 202. These wooden flashboards were removed by the department in January 1956. The dam proper, roughly triangular in cross-section, stands on limestone at el − 80.8 and reaches a height of 296.8 ft to the top of roadway at el 216. The spillway section on the north side of the valley rests on gneiss, much of which had to be removed to a considerable depth to secure a tight foundation and eliminate the many seams and faults. Erosions or open seams, showing on the surface of the rock on which the foundation was placed, were traced as far as possible and packed with small stones and grouting. A hand pump manned by 4–6 men was used to inject the grouting.

The laying of the foundation masonry was begun in May 1896. Most

of the stone, obtained from a quarry at Hunter's Brook, yielded a hard and tough granite weighing about 185 lb per cubic foot, and, in some cases, were 1–3 cu yd in size.

Above the foundation, the "hearting" of the overflow weir and of the main dam was built of rubble masonry, with the stones embedded in a matrix of concrete, and the whole faced with ashlar laid on ½-in. mortar joints in 20–30-in. courses.

square mile for a drainage area of 375 square miles. This rate, the greatest ever experienced over the spillway, continued for more than 4 hr, producing vibrations in the bridge arching the spillway and in the roadway near gatehouse No. 2, described by some observers as being very disturbing.

The greatest recorded flow in the Croton River prior to the design of the New Croton Dam was 8 bgd; this

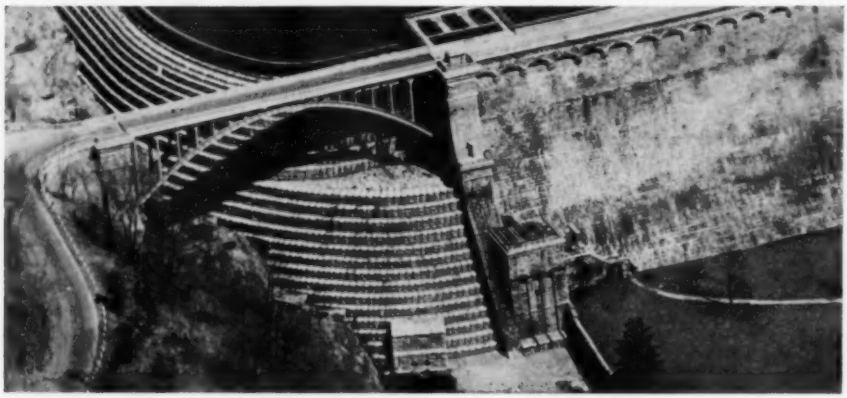

Fig. 1. Junction of Spillway and Dam

Storm Results

This solid construction became faulted, apparently as a result of the unprecedented overflow during the storm of Oct. 14–16, 1955. No significant leaks had been apparent prior to that time. During the storm 10.3 in. of rain fell on the Croton watershed, with a maximum of 7.1 in. on Oct. 15. This produced the maximum flood recorded since 1868 in the Croton area with a flood crest 3.84 ft above the flashboards (el 202)—almost 6 ft above the permanent crest of the structure.

The maximum daily rate of discharge was 14.8 bil gal or 61 cfs per

figure naturally influenced the designers in their calculations for the dam and spillway.

Analysis by engineers of the department, made immediately following the October storm, revealed that the following factors were used in the design of the structure: [1] the design head equals el 206; [2] no uplift was considered; [3] no ice pressure was considered; and [4] weight of masonry was taken as 156.25 lb per cubic foot.

Using the above data, the critical section was found to be at el 140, with the resulting of the forces considered falling at the downstream edge of the kern. Clearly, the head over the spill-

way during the October storm had subjected the dam to its full design pressure. Another effect of the storm was seen by those who were there at the time when vibrations generated by the tremendous turbulence of the cascading overflow made themselves felt.

Preliminary Measures

As a precautionary measure, wooden flashboards 2 ft in height were removed in January and February 1956; this was the only step possible until spring and early summer floods subsided and the conditions of the structure could be examined in detail.

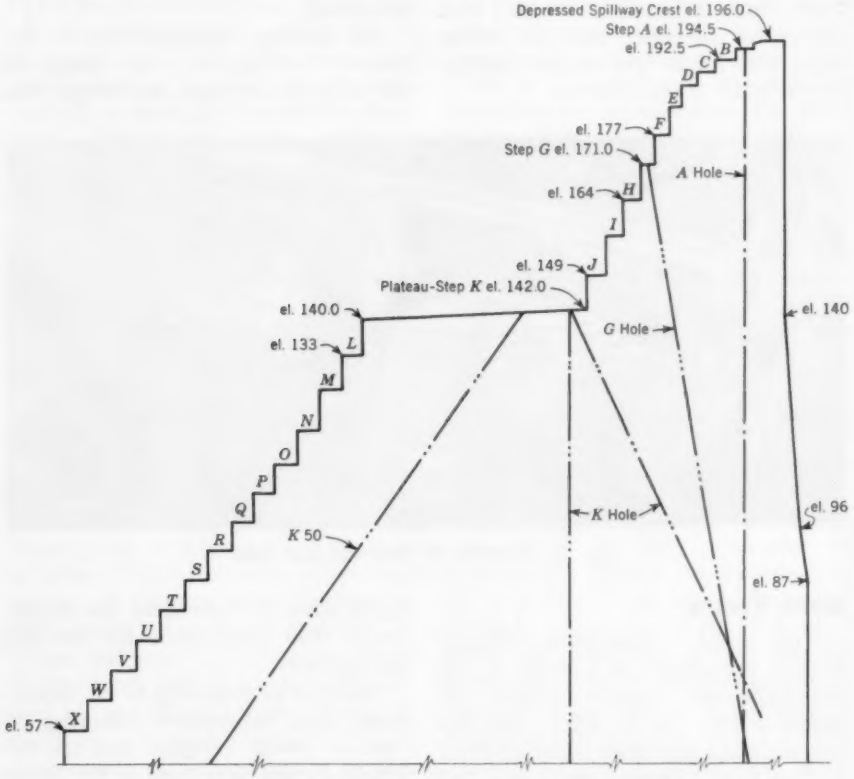

Fig. 2. Section of Spillway Near Junction With Main Dam

Later, when it was revealed that water had penetrated the structure, it was realized that some uplift must have been present, although venting by the passage of water through the structure provided some relief from possible internal pressure due to a loss in head as the water escaped.

On learning of the leakage through the stonework of the spillway steps in late July, a survey of the damage was immediately made by engineers of the department. The department then sought the advice of Irving V. A. Huie

and Stanley M. Dore, the president and chief engineer respectively of the Board of Water Supply, and requested their assistance and the help of their organization to decide on a repair program to guarantee the stability and watertightness of the structure. The following steps were agreed upon:

1. Immediate drawdown of the waters of Croton Lake to permit inspection of the upstream face of the spillway and dam
2. A joint effort in directing the repair program to be carried out through cooperation of certain experienced Board of Water Supply engineers with Department of Water Supply, Gas & Electricity staff
3. Obtaining the services of a firm of consulting engineers experienced in the field of water supply.

While preliminary preparations such as opening and repairing blowoff gates were underway, a meeting was arranged with the consulting engineers and members of the Board of Water Supply at the site of Croton Dam on Aug. 8, 1956. A detailed inspection of the entire structure followed. It was disclosed that old vertical temperature cracks in the upstream face of the masonry, which could be seen as a result of the already lowered water level at about 100-ft intervals, had been calked with lead and were still in perfect condition although installed in 1908. It was then determined that lead calking of the upstream face would be appropriate in this case, and that such work could start immediately.

It was also decided to follow this work by taking core samples with diamond drills from the top of the structure down into bedrock. A grouting program was envisaged, but nothing could be done before the first holes gave more definite information.

Boring and Grouting

The locations of all holes drilled are shown in Fig. 2 and 3. Core holes were drilled from el 194.5. This level was designated as Step A. All except two holes from this level penetrated vertically through the spillway masonry and extended 15–25 ft into bedrock. During drilling operations, wash water used to lubricate the bit carried out tailings through seams and to the face of the dam, revealing the course of some of the faulted areas. A line was plotted on a drilling chart to indicate the depth at which loss of water occurred in each hole. Dye tests were then used to trace the openings; further tests with water under pressure were made through a pipe expansion plugged into each hole at various levels to determine the location of seams in the masonry.

Fifteen core holes were drilled from Step A. Some cores were kept so that examination of the location of the faults in the structure could be made. It was soon decided, however, that dye tests and the water tests revealed more information concerning location and extent of faults than was obtained from the cores.

By this time, a decision was reached to extend the drilling so that an adequate grouting program could be started. Drilling was started from el 171 (Step G), and from el 140 (Step K). The latter is referred to as the plateau or bench.

Contracting firms had been ordered on the job under the emergency powers of the Commissioner of the Department of Water Supply, Gas and Electricity; work was done on a time and material basis.

In all, 35 holes were drilled—fifteen diamond core borings and twenty per-

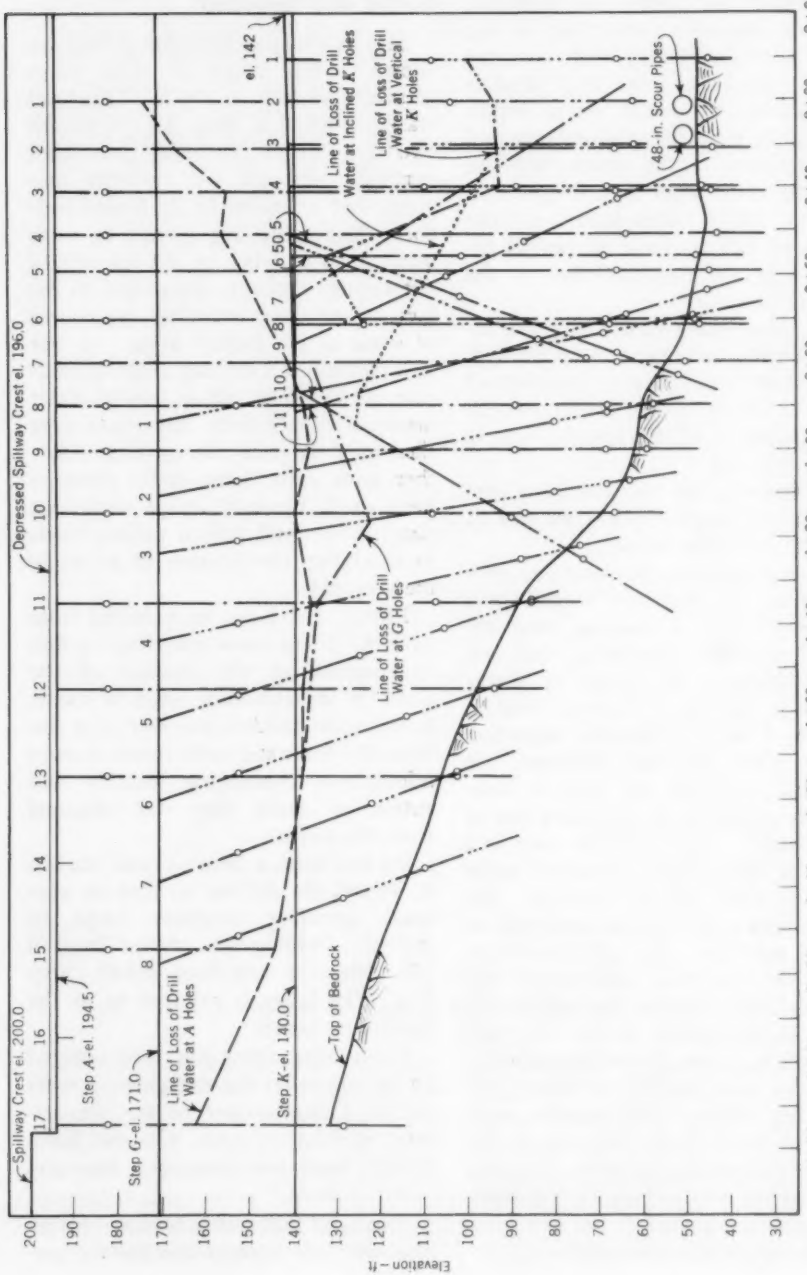

Fig. 3. Location of Drill and Grout Holes

In this full-faced elevation of the spillway, the main dam lies to the right.

cussion holes. The total length of core borings was 1,912 ft, with depths ranging from 140 to 164 ft, and averaging 127½ ft. All except two holes reached at least 15 ft into bedrock; the average drilling rate was 2½ ft per hour. Twenty vertical and inclined percussion holes were drilled from Steps G and K, with depths ranging from 80 to 144 ft, for an average of 104½ ft, and a total footage of 2,090 ft. The depth of 144 ft was cited as a possible record for percussion drilling, and the average drilling rate of 4 ft per hour was excellent at the depths and for the hard type of rock encountered.

All drilling was completed on Oct. 6, 1956. The final core borings were made when water pressure testing of holes began. Grouting procedures began on Oct. 11, and were completed on Oct. 18.

All 35 holes were grouted, using approximately 787 bags of cement with mixes varying from 10 gal water to 1 bag cement, to the thickest mixture of 6 gal water to 1 bag cement. Grouting of the spillway structure continued for 147 hr on a 24-hr day schedule, and was done in stages or lifts. The first stage was the insertion of the grout pipe into bedrock. The inserted end was plugged off. The grout pipe was then raised approximately 20 ft for each stage; great care had to be exercised, applying only sufficient pressure to cause the grout to flow from the faces of the structure.

It was apparent that, because of the stepped construction of the spillway face, grout pressure would have to be controlled in order to prevent an uplift of the granite blocks. Upstream joints which were calked simultaneously with drilling operations were provided with ¼-in. copper tubes at about 10-ft centers to vent air from confined spaces and to permit the grout to penetrate all voids reaching the wall face. In spite of the close spacing of drilled holes from 10 to 20 ft, center to center, there were only two instances of venting from adjoining grout pipes. Because of the high water–cement ratio necessary in grout mixtures, high shrinkage was inevitable. When the grout pipe was lifted to a successive elevation, grouting at the previous lift had time for partial set and shrinkage. Grouting at the higher lift, therefore, not only filled in new voids exposed to the drill hole but forced a layer of grout mixture into the void left by shrinkage in the preceding lift.

After grouting was completed, the blowoff gates were closed on Oct. 24, 1956, and storage of water in Croton Lake began.

Core borings taken through the grouted structure followed to determine the success of the work of filling the cracks.

It is expected that the grouting and calking operations will give two beneficial results: [1] exclusion of water from the interior of the spillway structure, thus securing water tightness and eliminating uplift; and [2] the restoration of the original structural integrity of the dam.

Finally, by common agreement with the consulting engineers, it was decided to remove the 4 ft of so-called permanent concrete flashboards which had been placed in 1907 to el 200 for the purpose of increasing the storage in Croton Lake.

Conclusion

The reduction of the spillway height to el 196, Croton datum, will accomplish a total lowering of the lake of 6 ft below the level existing before the storm of October 1955, and will

In this full-faced elevation of the spillway, the main dam lies to the right.

result in a very substantial reduction of water pressure against the entire Croton Dam.

Water, in Croton Lake, moreover, will have to rise 10 ft before equalling either the crest elevation (the original design head) or to the pressure upon Croton Dam obtained during the October 1955 storm. Such an amount of water would produce a discharge of 65.2 bgd, or 269 cfs per square mile—nearly 4½ times the intensity of the October 1955 storm of 63 cfs per square mile.

To produce such an amount of water on the Croton watershed would require the runoff of a 10,000-year storm for that area.

It may be pointed out that there occurred a much greater flood during August 1955 in the nearby drainage area of the Naugatuck Valley in Connecticut where the flow reached 570 cfs per square mile for a drainage area of 246 square miles.

The Croton Valley, however, is favored with the presence of twelve large reservoirs and a chain of lakes in the New York water supply system with a combined water surface of more than 17 square miles. This water surface provides a potential of temporary storage above spillway levels sufficient to absorb more than 3 bil gal per foot of height, and acts as a cushion to reduce the flashy nature of a flood.

With the changes now being completed at New Croton Dam, it is believed there is little likelihood of the structure ever again being subjected to the forces generated during the October 1955 storm. The loss in storage and yield of the Croton system due to lowering the spillway is now of small consequence in view of the recent addition of the Delaware system to New York City water supply.

Acknowledgment

In the joint effort directed by the engineering personnel of the New York City agencies, the Department of Water Supply, Gas and Electricity and the Board of Water Supply, Edward J. Clark, Chief Engineer of the department, and Frank X. Elder, Deputy Chief Engineer, were in charge of organizing the job, with the assistance of Fred C. Stein, Division Engineer in charge of upper New York State watersheds, Abraham Brown, in charge of Designs, Abraham Groopman, of Water Supply Control.

John Kelly, Senior Civil Engineer, East Side of Hudson River, Leroy Bichwit, Civil Engineer, Don Grassman, and others, pushed the job for long hours without stint.

The part played by James Cooper, Civil Engineer, Board of Water Supply, in organizing and directing the grouting procedure must also be mentioned. The department also appreciated the cooperation extended by Irving V. A. Huie, President of the Board of Water Supply, Mr. Stanley M. Dore, Chief Engineer, as well as the work of Karl Kennison, Special Consultant for Malcolm Pirnie Engineers, in a study of the stability of the dam.

Taste and Odor Control at Philadelphia

Elwood L. Bean

A paper presented on Nov. 8, 1956, at the Virginia Section Meeting, Old Point Comfort, Va., by Elwood L. Bean, Chief, Water Treatment Section, Water Dept., Philadelphia, Pa.

TREATMENT of water for taste and odor control to meet modern aesthetic demands, particularly without modern treatment facilities, may be a very difficult and complicated matter. In Philadelphia, the sources of raw water are two rivers, the Schuylkill and the Delaware, both of which are polluted by wastes of other communities and by industrial wastes. There have been many changes in conditions in both rivers since the author's last article on this subject (*1*).

Schuylkill Water

The Schuylkill, which has a dry-weather minimum flow of only 200 mgd, rises in coal-mining areas where iron and manganese are plentiful, and flows through a limestone region and a highly industrialized area. Until recent years, the Schuylkill received industrial wastes from more than 40 different industries. The wastes generally reached the river with little or no treatment, as was true of the waste waters from a number of communities of considerable size. Coal culm and acid mine-drainage also entered in great quantities, the former filling the river with deposits, the latter dissolving enough minerals from the limestone over which it passed to produce moderately high hardness. Because of the quantity entering, there was still generally enough acid to keep the pH in the vicinity of 6.5–6.7. Wastes and decomposition resulted in dissolved oxygen saturation of less than 60 per cent in many months.

Because of the variety of the sources of pollution, many types of odor and taste were produced. In addition to those of natural origin, such as woody, vegetable, and algae tastes, the wastes frequently caused phenolic, chlorophenolic, iodoform, and medicinal tastes and odors. The phenolics were chiefly derived from coking plants, gas production plants, and steel mills.

The city maintained a daily patrol of the river to check on pollution entering, to keep plant management informed, and, in all possible ways, to minimize the extent of pollution. In the treatment plants, before 1947, no control of taste or odor was practiced except the negative one of trying to hold chlorination below the point where it developed tastes or odors—a very unsuccessful control.

At both the Belmont plant (Fig. 1) and Queen Lane plant (Fig. 2) approximately half the water was filtered through slow sand filters and half through rapid sand filters only. At Queen Lane, the slow-sand water was prefiltered, though that fact has no special significance to the subject. Biological oxidation within the slow sand filters produced very marked reductions in the intensity of tastes and odors of practically all kinds. The rapid sand filters produced no such

appreciable reduction, and, as a first step toward control, carbon feeders were installed at both plants for application on the water to be rapid-sand filtered. Dosages of activated carbon as high as 16 ppm were required at times, though generally they did not exceed half that amount.

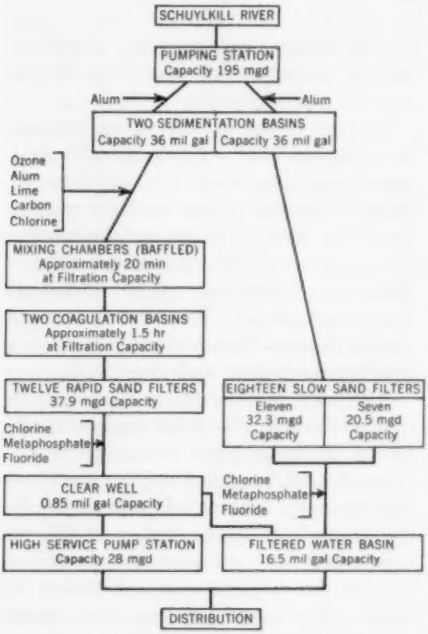

Fig. 1. Flow and Treatment Diagram of the Belmont Plant

Carbon was very successful in removing the phenol-like tastes and odors caused by a variety of wastes. Objectionable tastes of this type were not produced after chlorinating, as they had been previously. Plant operation confirmed experimental tests, in that very high quantities of carbon were required to remove the major part of the organic tastes (generally termed "musty" or "mouldy)." Complete removal was rarely accomplished.

Chlorine was found effective in destroying these musty or mouldy tastes at the Queen Lane plant, although the nitrogen trichloride formed and present after short detention caused objections. Detentions of 4–6 hr in closed, filtered-water basins, following the free residual chlorination, resulted in considerable nitrogen trichloride reaching consumers. This, however, was much less objectionable than the water without such treatment. Increasing the dosage to the zone of superchlorination, and use of sulfur dioxide at the basin outlet, where water enters the distribution system resulted in a great reduction in those tastes and in odors characterized as nitrogen trichloride.

At the Queen Lane plant, since the installation of facilities for free residual chlorination of the raw water in 1950, a presedimentation basin, providing 16–20-hr detention, has been utilized as a contact basin for the chlorine after breakpoint. This contact has eliminated the nitrogen trichloride problem. Postchlorination is needed only to the extent necessary to boost free chlorine residuals to the range desired for entrance to the distribution system.

At the same plant, chlorine contact time, between application and actual determination of residual, is about ¾ hr. It is necessary that dosage be such as to show free chlorine equal to at least 80–85 per cent of the total residual. Lower percentages will not result in total destruction of organic tastes and odors because the slow oxidizing organic compounds will consume free chlorine without being completely oxidized. Chlorine applications as high as 15 ppm were required at one time when the river froze over, and 8–10 ppm was not uncommon.

At the Belmont plant, instead of providing for free residual chlorination, an ozone plant was built and placed in operation in 1949 to treat the water being prepared for rapid sand filtration. The ozone engenders oxidation in a manner similar to free chlorine and, in the few minutes' (10–20) retention period in the contact chambers, destruction of oxidizable material is accomplished. Substances resistant to oxidation by ozone are similar to those not oxidizable with free chlorine, although ozone is, perhaps, less effective on the natural musty-mouldy organics and more effective on industrial waste materials. However, that ozone does split musty odors has been demonstrated.

In 8 months of 1951, with ozonation functioning, less than 20 per cent of plant effluent samples had cold odors characterized as musty or "related." In the same months of 1952, with no ozonation, in spite of the use of carbon, 28 per cent had such odors.

Ozone residuals will not persist, and, therefore, all action must be accomplished in a matter of minutes. The extent of action is similar to that of free residual chlorination, with a contact time of 10–20 hr instead of the minutes required with ozone. Ozone speedily splits many of the organics which are slow to react with free chlorine. Where time of contact is a major factor, therefore, ozone may be definitely advantageous. The nitrogen resulting from destruction of organic compounds remains in the water; if free chlorine residual is later to be produced for delivery to the distribution system, therefore, the demand for chlorine may not have been appreciably reduced by the ozonation.

Effects of Cleanup

In the early 1950's, the Schuylkill was dredged from Norristown to its headwaters, removing coal culm and all the other wastes which are even more harmful to water quality; the federal government did the same

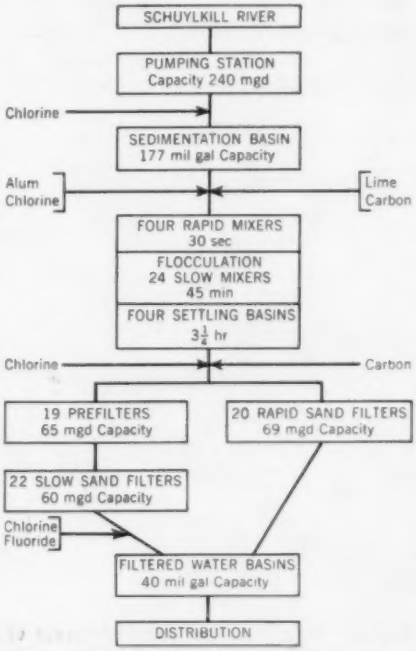

Fig. 2. Flow and Treatment Diagram of the Queen Lane Plant

below Norristown to the Fairmount Dam which is at the head of tide water, and forms the pool for supply of the Queen Lane and Belmont plants. In addition, within the past decade, the State Sanitary Water Board has, where necessary, compelled construction of waste treatment and sewage plants. Only one rather small community now discharges untreated sewage, and the major untreated wastes have been eliminated or treated,

either by the industries responsible or in the community sewage plants.

The removal of organics from the river bed, and their practical elimination from waters entering, has helped markedly in reducing the intensity of organic tastes, although musty odors are as prevalent as previously. The reduction of phenolic-type wastes and the adoption of free-residual chlorination and ozonation have resulted in near elimination of carbon use. The

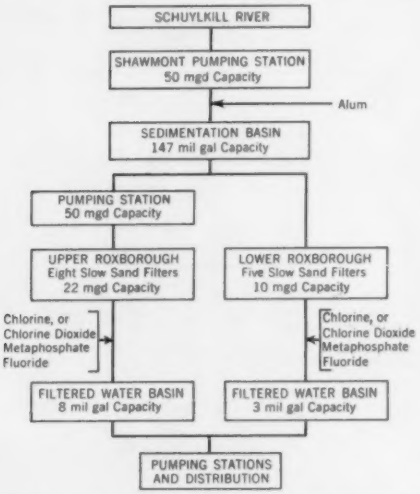

Fig. 3. Flow and Treatment Diagram of the Roxborough Plant

total quantity used in the Belmont plant in the past 4 years amounted to only 2 tons, compared with 86 tons in 1949. At Queen Lane, for the same period, 25 tons were used compared with 215 tons in 1949. Of late, carbon has been used on a few days as the result of apparently accidental spills of untreated wastes from the industries. Chlorine demand for breakpoint has been materially reduced and is more stabilized, with normal demands below 7 ppm. The only higher demand in the past 4 years occurred when dumping raised the demand to 11 ppm at Queen Lane. Tests seem to indicate that the material dumped was a detergent.

The river clean-up resulted in very marked turbidity reduction, from yearly averages of 60–75 down to 20–30; in some increase in the true color, averages of under ten rising to thirteen; in increased dissolved oxygen, from under 75 to over 85 per cent saturation; and in increased pH, which averaged 7.5. All these factors favor increased growth of green, blue-green and other types of algae. They have reacted to these conditions, and decided increases in both number and type of algae growths have been experienced. High dissolved oxygen and high pH (8.0 or more) have many times resulted. Tastes and odors caused by algae in the river waters have generally been oxidized by the free chlorine or by ozonation; carbon was necessary for this purpose for only a few days. Algae growths in the large sedimentation basins at Belmont and at the Roxborough plant (Fig. 3), where free residual chlorination was not in use, have required the application of copper sulfate in summer seasons to control algae growths in water being prepared for slow sand filtration. This was necessary to prevent clogging by the organisms of the filters, and because biological action in slow sand filters cannot always eliminate tastes due to algae—although it does greatly reduce them.

A new pretreatment plant now in operation at Queen Lane provides rapid mixing and 45 min of mechanical flocculation for proper floc formation. Sludge is continuously removed from the settling basins by mechanical

scrapers. These are definite factors in the taste and odor picture. At the Belmont plant, which lacks these modern facilities, the coagulation and settling basins are drained, and sludge flushed out each spring and fall, a common practice. Even so, in the summer season, gas formation, often evident in the accumulated sludge, undoubtedly has a detrimental effect on taste and odor.

Another factor is cleanliness of filters. Surface wash of the rotary type, and a good underdrain system, together with careful control of treatment to produce proper flocculation has, in recent years, resulted in very clean filters in the Belmont plant. At Queen Lane all filters are being rebuilt, with modern underdrains and other facilities, including semiautomatic control of filter washing.

Delaware Water

The Delaware River, with a dry-weather minimum flow at Trenton of 1,100 mgd, is the source of supply for half the Philadelphia water. This is treated at one plant only, the Torresdale plant (Fig. 4), located on the river in the northeast corner of the city. Normal plant output is about 200 mgd. In the 1940's, treatment consisted of chemical application for flocculation, sedimentation in a 170-mil gal tidal basin which refills twice daily, chlorination, filtration through rapid type prefilters and then through slow sand filters, followed by post-chlorination in the amine range. There was no special treatment provided for tastes and odors. River water contained some tastes and odors which were, to a considerable degree, removed by the biological oxidation in the slow sand filters. Recorded odors were generally classed as aromatic, earthy, or oily-vegetable. Oily-aromatic is probably the best characterization of the somewhat continuous background taste. This was not strong enough in the distribution system to cause major numbers of customer complaints, but was sometimes referred to as the "Delaware River taste." Oily tastes were due to some industrial wastes

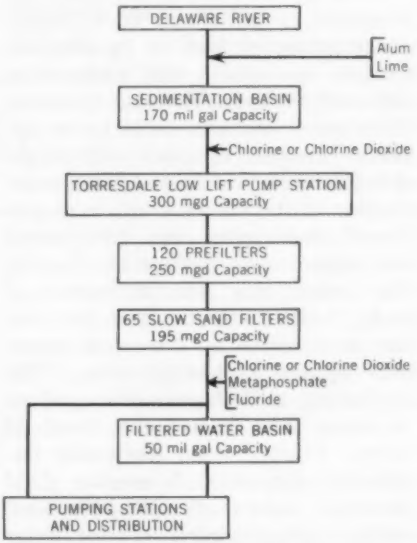

Fig. 4. Flow and Treatment Diagram of the Torresdale Plant

along the river, and to bilge pumpage and oils from ships, because this tidal portion of the river on which the Torresdale plant is located carries a considerable amount of shipping Aromatic odors were caused by acrylate wastes from a plant manufacturing plastic glass, located about 6 miles upriver from the Torresdale plant.

In December 1948, tastes and odors began to increase about the middle of the month, and continued until Christmas Day, when they produced com-

plete unpalatability at taps. It was evident that some industry was dumping unusual materials. Dropping temperatures, with reduced biological action in the river, were, no doubt, a major factor in the increases. Tests showed that chlorination, in any normal quantities, was detrimental to the taste, but that carbon in sufficient quantities removed most of it.

With no facilities in the plant for treatment of tastes and odors, emergency measures had to be adopted. Carbon was mixed with alum when delivered to feeder bins, but comparatively small amounts could be so applied. Barrels equipped with high-speed mixers, water inlet, and water eductor to the dosing point were employed, and carbon was thus wetted and applied, very inefficiently, because the carbon was lumped instead of being well diffused. By the two means, as much as 7 tons of carbon were applied in a single day. This application of 70 lb per million gallons no more than halved the threshold odors. Filtered water was rather unpalatable for about 5 weeks. Cold threshold odors of 200–500 were several times recorded on river water at the intake.

Intensive investigation by the city and by state health departments of Pennsylvania and New Jersey established that two industries were discharging both (2,4-Dichlorophenoxy)-acetic Acid and phenol wastes in major amounts, and that a third was discharging phenols. Eventually the 2,4-D manufacture was discontinued on this watershed.

Shortly after this experience, chlorine dioxide equipment was ordered. This was installed during the summer of 1949 as a part of the postchlorination phase of treatment. Two generator units and two pumps were used, but only one dissolving tank served for the sodium chlorite. Three 2,000 lb per day chlorinators discharged into a single conduit. Free residual chlorination on this posttreatment was practiced, and the chlorine dioxide was used only a few days later in 1949 when odor or taste materials passed the slow sand filters.

In the year 1950, chlorine dioxide was required on fifteen different occasions for a total of 85 days, because of the persistence through filtration of river water tastes and odors. By 1951, dumping of phenols at one of the major sources was stopped. At a second major source, the manufacturer was required to install two large trickling filters and four large lagoons, the worst wastes passing through the four lagoons in series. When the fourth lagoon is filled (about four times each year) the filter plant laboratory is informed, samples are taken for analysis, and a rate for discharging the material to the river is established in accordance with the analysis, known tolerances, and the existing river conditions. At times, the manufacturer has been ordered to chlorinate the materials before passing them into the final lagoon. Dosages as high as 300 ppm have been required to split the ring compounds which are not completely oxidized by the trickle filter, and the acrylate wastes (from manufacture of plastic glass) with which they are mixed. Since these treatment and control procedures were established, no difficulty has been experienced from this source.

Phenolics in the intake water of the Torresdale plant built up to a maximum in 1954. In that year the sodium chlorite used in generating chlorine dioxide was 163,000 lb, the cost of the

chlorite being $96,460—an average of about $1.42 per million gallons for the total plant output during the year.

The third source of phenolics, previously indicated, was responsible for most of the difficulty. This manufacturer is located on a stream ¼ mile from the river, the stream entrance to the river being 3 miles downstream from the Torresdale water intake, but on the same side of the river. Tidal action carries materials upstream, and there is a distinct tendency for the materials from the creek to follow the river bank on incoming tides to the water intake. Tests from sampling points along the river bank indicated a die-away pattern from creek to plant, but was not too conclusive because of small, local, waste interferences near sampling points. Numerous series of samplings made by boat during incoming tides, indisputably established the fact that the pollution was coming from the creek. The heavy concentrations at the mouth of the creek, tapered off at upstream points and became negligible a mile or two above the plant intake.

Under pressure from the State Sanitary Water Board, the manufacturer reduced the wastes by use of dephenolizers, traps to catch spills, and other means, and then applied for permission to dispose of the remainder in city sewers. The effects on the activated sludge plant of such disposal was debated and, finally, temporary permission to connect to the sewer was given. Nearly all of the phenolics (about 600 lb per day), together with 3–4 tons of sulfite, have passed to the sewage treatment plant in the past 16 months. The sewage treatment plant destroys 80–85 per cent of the phenols, and the remainder passes on to the river.

The methods outlined have resulted in a decided improvement at the Torresdale plant. The marked drop in phenolic type odors to 50 per cent was paralleled by a reduction in sodium chlorite use to 96,000 lb during the first 12 months of disposal to the sewer, against 178,000 lb in the 12 months immediately preceding—a reduction to 54 per cent.

Phenolic Odor Index

Lacking a better yardstick for comparison of conditions in river water, the author has employed a very inexact procedure which consists in taking the product of the per cent time (percentage of time during any 8-hr period when odor occurred) and the average threshold odor number found. Using this method, the monthly averages for phenolic, gassy, and tarry odors (as shown in Table 1) have been computed. Comparisons with the amount of sodium chlorite used each year are made, and percentages of the 1954 figures (as 100 per cent), are also given.

In the years of increasing phenolic loadings at the plant intake (as indicated by the increase in the monthly average of threshold odors) the relation of 1951 and 1953 to 1954 was direct; with decreasing phenolic loadings in 1955 and 1956, the relation is not. This is largely or wholly due to three factors: [1] Large percentages of the chlorite were used in pretreatment rather than post-treatment, and the former is less efficient per unit of pollution because part of the chlorite reacts with materials which would normally be removed in filtration. [2] In 1955 and 1956, other organic materials than those used in these calculations (such as hydrocarbons and organics which cause septic-musty

odors) were present in unreduced, or even in increased, amounts relative to preceding years. [3] The standard of quality of water which the plant is expected to produce is continually rising; the oily-aromatic "Delaware River taste," or any other taste, is no longer acceptable to either the personnel furnishing the water or to the consumers.

Biological Action

Along the river front, between the creek previously noted as a source of phenolic pollution and the intake, are several combined sewer overflow outlets. Before construction of the sewage plant, the overflow outlets discharged *all* sewage direct to the river. That seeding of the raw sewage bacteria to the river effectively aided the biological destruction of phenols is believed to explain the following phenomenon. In several years there is evidence that pollution entering the river at the creek was equal approximately to that in 1953 to 1955, although the amount of phenol reaching the intake was very much less. Apparently it was removal of the seeding which resulted in greatly reduced destruction of the phenols in this section of the river.

Phenolic conditions at the water intake are greatly affected by the seasonal changes in temperature. There is reason to believe that the amount of wastes entering the river is somewhat constant throughout the year, and the wet and dry seasons do not correlate with the changes in phenolic concentration at the intake. Changes in phenolic concentrations appear, therefore, to be due to changes in biological oxidation in the river. Correlation of the factors of temperature, phenols, and chlorine dioxide use, in terms of amount of sodium chlorite applied, is indicated in Table 2.

TABLE 1

Quantity of Sodium Chlorite Used Relative to Level of Phenolic Odors

Year	Monthly Average,* Phenolic Odors	$NaClO_2$ Used During Year lb	Percentage of 1954	
			Monthly Average	$NaClO_2$ Used
1951	15	54,000	27	33
1952	15	77,000	27	47
1953	29	93,000	53	57
1954	55	163,000	100	100
1955	28	161,000	51	99†
1956	13‡	100,000§	24	61

* Product of per cent time and average threshold odor number.
† Fifty-five per cent of dosage applied in pretreatment.
‡ First 9 months of the year only.
§ November and December estimated.

The data shown in Table 2 are not all for the same periods but it should be noted that for the past year, phenol tests have shown 61 per cent of the total detected was present in the six colder months, and that during the preceding year the figure was at least 98 per cent. It is significant, too, that over the past 8 years, the colder months account for 71 per cent of the odor threshold-per cent time product. Chlorite use in the six colder months, for the past 7 years, averaged 90.5

per cent of the total, or 9.5 times the use in the six warmer months. The difference between the two preceding percentages may result from the fact that the phenols present in intake water in the warmer months are generally largely or wholly oxidized in the slow sand filters. (Relation of the monthly averages at Torresdale is shown in Fig. 5.)

It was found by Howard (*2*) that taste could be caused by as little as 2 ppb phenol. Braus, Middleton and Walton (*3, 4*) found that material extracted from raw water at Columbus, Ohio, would give odor at concentrations as low as 3 ppb.

Table 2 shows that monthly averages of phenol content of river water have, within the past year, ranged to over 30 times the amount which Howard found to cause taste. The tests show monthly averages ranging from 4–63 ppb since the spring of 1955. Before that time, averages ran hundreds and even thousands of parts per billion.

Howard also found that with dosing to the free chlorine range, the iodoform taste was "completely eliminated" from a 17-ppb concentration of phenol. Studies made under S. J. Campbell, Chief Chemist of the Torresdale laboratory, showed that concentrations of 8 ppb were removed by dosage of 7.5 ppm chlorine and that 100 ppb was destroyed by about 75 ppm chlorine, at a cost of $32.19 per million gallons.

Chlorine dioxide studies by the same chemist have shown that 100 ppb phenol was destroyed by 0.07 ppm of chlorine dioxide which, produced from commercial (70 per cent) sodium chlorite and chlorine in a 1:1 ratio, would require 1 lb each of sodium chlorite and chlorine, at a cost of 65 cents per million gallons.

Certain limited studies by Campbell (*5*) on the slow sand filters have indicated that they may oxidize up to 300 ppb of true phenols in warmer months, and about 70 ppb in winter months.

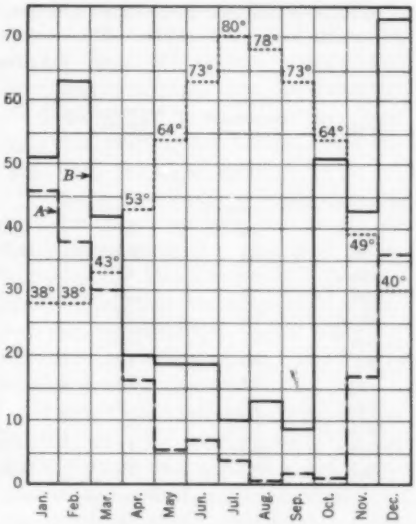

Fig. 5. Relation of Water Temperature, Sodium Chlorite Use, and Average Phenolic Odors

Line A *represents sodium chlorite use (in per cent of annual use) for the period November 1949 to October 1956; Line* B, *Phenolic Odor Average (the product of the cold threshold odor number and per cent time) for the period October 1948 to September 1956; the dotted lines, monthly average temperature levels for period 1950–55 (with temperatures indicated in degrees Fahrenheit).*

Because he found no phenols in samples of the *schmutzdecke*, after passage of the phenols, he has concluded that the action can be biological oxidation only, not absorption.

In actual plant operations, phenol is not appreciably affected by passage through prefilters, but levels to about 90 ppb have been satisfactorily handled by the normal plant when water temperature was in the vicinity of 60°F. Because there is no appreciable adsorption on floc, the slow sand filters must be credited with this destruction.

In past years, phenol levels in the filtered water were sometimes such that the chlorine dioxide demand required sodium chlorite in dosages as high as 5–6 lb per million gallons. With such dosage, there results what can be termed only as an aftertaste; technicians recorded it simply as "chlorite taste." This was the cause of some complaints, but it did not persist throughout the system. The taste was reported only in areas where flows are such that the time needed to reach consumers' taps, after the application,

TABLE 2

*Relation of Seasonal Temperature Changes, Presence of Phenols, and Chlorine Dioxide Use**

Month	Water Temperature Average† °F	Average, ‡ Phenolic Odors	Average Presence of Phenols ppb		Sodium Chlorite Applied	
			Period			
			Nov. '54–Oct. '55	Nov. '55–Oct. '56	Percentage of Yearly Use	Yearly Use lb
Jan.	38	51	3,508	25	23.1	21,768
Feb.	38	63	1,825	22	19.0	17,949
Mar.	43	42	190	28	14.8	13,928
Apr.	53	20	61	42	7.1	6,680
May	64	19	33	35	2.7	2,527
Jun.	73	19	21	49	3.4	3,235
Jul.	80	10	17	4	2.0	1,850
Aug.	78	13	18	14	0.2	219
Sep.	73	9	28	18	0.8	726
Oct.	64	51	50	28	0.4	340
Nov.	49	43	—§	49‖	8.5	8,026
Dec.	40	73	4,225§	63‖	18.0	17,021

Extent of Period	Temperature for Period	Percentage of Total of Phenolic Odor Averages, 1948–56	Percentage of Total Phenol Detected		Percentage of Total Chlorite Used 1949–56
			Nov. '54–Oct. '55	Nov. '55–Oct. '56	
6 Months	Above 55°F	29	2	39	9.5
6 Months	Below 55°F	71	98	61	90.5

* Chlorine dioxide use is stated in terms of sodium chlorite applied. Note that data shown are not all for the same period.

† For period 1950–55.

‡ Product of per cent time and average threshold odor number. For phenolics at water intake; period Oct. 1948–Sep. 1956.

§ For Nov. and Dec. 1954 only.

‖ For Nov. and Dec. 1955 only.

was probably less than a day. Some difficulty with this appeared even with 3 lb chlorite per million gallons. Provision, therefore, was made for the application of chlorine dioxide on pretreatment, in order to lessen the load which would reach filter effluents. Since Nov. 1953, pretreatment with chlorine dioxide has been applied whenever it appeared likely that a posttreatment of chlorite, exceeding 2 lb per million gallons, might otherwise be required. Thus, aftertastes in the system have been avoided, except for occasions when demands for river loadings have exceeded the capacity of pretreatment facilities, again requiring too high postdosage.

Hydrocarbons from shipping wastes, oil spills, and oily wastes along the water front are prevalent in the Delaware water. Chlorine dioxide oxidizes the hydrocarbons.

Algae Control

One branch of taste and odor control is, of course, the control of algae where there are open reservoirs in the distribution system. In the Philadelphia system, there are two open reservoirs: one, of three sections, with total capacity of 688 mil gal (East Park Reservoir), receives the treated Schuylkill water, which has a hardness averaging 130 ppm and a nitrate content of 1.5–2.5 ppm; the other, of two sections, with total capacity of 70 mil gal (Oak Lane Reservoir), receives the treated Delaware water, which has an average hardness of 55 ppm and a nitrate content of 0.75–1.5 ppm.

Before the adoption of metaphosphate treatment of filtered waters to control corrosion, a somewhat reasonable, though not good, control of the algae growths was accomplished by surface applications of copper sulfate—perhaps a half dozen times a season. When metaphosphates were applied to the water which reached these reservoirs, growths multiplied. During two successive seasons, surface applications of copper sulfate failed to control growths in the larger reservoir, and tastes and odors became so obnoxious that the reservoir had to be cut off from the system. Since that time, metaphosphate has not been applied to water passing to the large reservoir, and copper sulfate alone has been used for algae control.

These experiences indicate that the presence of phosphates and ample nitrates mean trouble. The level of nitrates in the Delaware water is much lower than that in Schuylkill water, but still, apparently, ample as algae nutrient, as indicated by experiences on the smaller reservoir.

At the Oak Lane Reservoir, copper sulfate was fed continuously to incoming water and applied to the water surface to combat algae growths after the metaphosphate treatment. With the copper content built up to 1.5 ppm in the reservoir outlet, growth increase was retarded but the water still remained green and complaints were received. There were also complaints from certain industries regarding the high copper content. As a result of research work at the Torresdale laboratory, chlorine dioxide was applied at this reservoir, as reported by Ringer and Campbell (*6*). It produced excellent destruction of algae and, fed continuously to the inlet water and to the crossover to the second basin in correct amounts, it is possible to maintain algae counts under 200 throughout the season. Considered by itself, the treatment seems expensive ($12,000–14,000 dollars per year).

It does not seem so, however, when it is considered that this is necessary in order to be able to control corrosion in the entire treatment plant output for over a million people.

It is now desirable, hydraulically, to pass Torresdale water through the East Park Reservoir. This presents a real problem, because costs for chlorine dioxide control would be much more than proportional to the capacities, and might run to a quarter of a million dollars yearly; yet phosphate control of corrosion on this water seems essential.

New Construction

At the present time, a new complete treatment plant, including all chemical and filtration facilities, is under construction at Torresdale, with a possible capacity, at a 3 gpm per square foot filtration rate, of 423 mgd. At Queen Lane, a new chemical treatment plant was dedicated in 1955 and is in operation. All the rapid type filters are being rebuilt into a modern filter plant with a possible 3 gpm per square foot capacity of 180 mgd. Under design at Belmont is a chemical treatment plant and twelve new rapid sand filters which, with rebuilding of the present twelve, make a possible capacity, at the 3 gpm per square foot rate, of 108 mgd.

When completed, the following will be true of each of these plants:

1. Large existing basins will provide many hours of contact for free residual chlorination before other chemical treatment. (Ozone use will be limited to the present installation since there is available the long detention needed for the use of free residual chlorination.)

2. Activated carbon application will be provided so that adsorption may be available to handle any materials which cannot be oxidized.

3. Chlorine dioxide application will be provided for standby on all post-treatment points and for pretreatment on the Torresdale Plant.

4. Rapid mixing, mechanical flocculation, and continuous sludge removal will be provided to insure proper floc formation for clarification and for freedom from sludge gases.

5. Filter underdrains, wash provisions, and surface wash with semi-automatic wash control are planned to maintain the filters in the cleanest possible condition.

6. The present policy of maintaining a laboratory in each plant, staffed around-the-clock by at least one control chemist, will be continued. The chemist is charged with the responsibility of checking water quality and specifying chemical treatment to obtain water of the best quality the plant will produce.

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Air Conditioning Expansion and Regulation

Thomas B. Robinson

A paper presented on Sep. 12, 1956, at the Michigan Section Meeting, Kalamazoo, Mich., by Thomas B. Robinson, Cons. Engr., Black & Veatch, Kansas City, Mo.

WITHIN the past 10 years, the water works industry has become increasingly alarmed over the rapidly accelerated growth of air conditioning and its effect upon water demands. There have been numerous articles published in the trade journals outlining the problem, prognosticating its probable future expansion, and recommending various solutions.

The tremendous growth in water consumption since the end of World War II has resulted from many factors. Some of these are automatic dishwashers and washing machines, garbage disposal units, and the general prosperity of the times which has contributed to waste and extravagance. The two principal causes for increased water consumption, however, have been air conditioning and lawn sprinkling. Either of these alone would have imposed a severe load on the water systems of the country, but, together, they have, in many places, created demands greatly in excess of existing capacity. The air-conditioning and sprinkling load constitutes over 50 per cent of the maximum day water demand in a majority of our cities. Although the sprinkling load has increased greatly in recent years as a result, at least in part, of the number of lawn-sprinkling systems being installed which use less expensive plastic pipe, the sprinkling load has always been sizable, and the percentage increase in recent years cannot compare with the percentage increase in the air-conditioning water load. In addition, the diversity factor of the sprinkling load is far better than that of the air-conditioning load. It is safe to assume that practically all of the air-conditioning units installed are in operation during the hot hours of a hot day, while the lawn sprinklers may be on only once or twice a week, and then on different hours of different days. Also, most rate schedules were established recognizing the lawn-sprinkling demand, and revenues are, therefore, adequate to compensate for its poor overall load factor. On the contrary, the air-conditioning demand with its poor load factor is relatively new, and most rate schedules are not set up properly to obtain sufficient revenue from the air-conditioning user to cover the cost of serving him.

Scope

Although the water works industry has definitely recognized the problem which air conditioning is creating, it may be of value to give some indication of its potential scope. Prior to 1946, practically all air conditioning installed was for commercial and industrial use. In that year, however, the trend toward residential air conditioning got under way and has veritably snowballed ever since. Indicative of the acceptance of home air con-

ditioning are the data of Table 1 which show the number and dollar volume of compressors and self-contained units sold for air conditioning from 1946 to 1953. The US Census Survey of Manufacturers, from which the data were obtained, has not been published for subsequent years, but it is safe to assume that the accelerated rate in growth of sales has continued in the years since 1953.

The falling unit cost for the self-contained air-conditioning units is indicative of the aggressive sales programs and keen competition which exist in the industry.

TABLE 1

*Number and Dollar Volume of Compressors and Self-Contained Units Sold for Air Conditioning, 1946–53**

	Compressors		Self-contained Units		
Year	Number	Dollar Value	Number	Dollar Value	Unit Cost —dollars
1953	2,380,739	121,054,000	1,137,293	293,694,000	258
1952	1,677,300	71,047,000	438,464	135,579,000	309
1951	1,051,937	56,669,000	282,488	93,573,000	331
1950	954,368	46,977,000	257,263	86,913,000	338
1949	604,431	29,929,000	123,709	50,584,000	409
1948	459,390	33,493,000	111,620	49,008,000	440
1947	Not available	34,586,000	74,796	39,509,000	528
1946	191,770	15,377,000	47,464	19,500,000	411

* Data obtained from the US Census Survey of Manufacturers.

Air-conditioning use, like water use generally, can be classified in residential, commercial, and industrial categories. Extensive growth in all three is certain. Residential air conditioning was considered definitely a luxury in 1946 and 1947. With our improving standard of living, however, it is rapidly becoming more of a standard household item, particularly in the warmer parts of our country. Automatic washing machines and dryers, garbage disposal units, and television were considered luxuries only a few short years ago; now they are accepted as essentials in most households. It is predicted that, by 1963, practically all new homes will be equipped with central units for year-round air conditioning. On the basis of 1,000,000 new homes per year, predicted by the real estate and builder's trades, this alone would constitute a sizable increase in the air-conditioning load. However, more and more of the older homes will also be installing air-conditioning equipment. In 1954 there were approximately 25,000,000 homes in the United States with central heating systems. Of this number about 6,000,000 had forced-air systems which are readily adaptable for installation of central air-conditioning systems. An additional 7,500,000 homes had gravity air-heating systems which can be adapted for central air-conditioning systems by minor revisions in the duct work. The remaining 11,500,000 homes which are heated with steam or hot water can be air conditioned by individual room window units.

Water Demand

Insofar as the water demand is concerned, residential air conditioning may very possibly not impose as heavy a demand as has been estimated previously, because the trend, at present, is toward more air-cooled and fewer water-cooled units. The average home will require about 3 tons of air conditioning, while the larger homes will require 5 tons or more. Based on a power rate of 2.5 cents per kilowatt hour, a water rate of 30 cents per 1,000 gal, and fixed charges based on current prices, the annual cost of operating a 3-ton air-cooled unit is less than that of a 3-ton water-cooled unit, and comparable costs for 5-ton units of the two types show very nearly the same relation. The price of water-cooled units is approximately the same today as it was 2 years ago, and the price of air-cooled units has fallen from 10–20 per cent during the same period. If the present trend continues, therefore, the bulk of future home air conditioning will probably be air cooled and, if so, will pose no serious problem for the water works industry.

Most business and commercial air conditioning, however, is of a size which probably will exceed the capacity of economically air-cooled units. Except in areas where power is exceedingly cheap, such as those where federal subsidies are in effect through the public power program, the electric power requirement for operating the larger air-cooled units will make them economically impractical. Air conditioning has become such an accepted necessity in most areas that business establishments and office buildings are forced to air condition in order to meet competition. The American Institute of Management has stated that when 15 per cent of the available office and commercial business space in a given community is air conditioned, air conditioning becomes a competitive necessity. Many of the larger cities in the Southwest and Midwest have already exceeded this figure.

Industrial air conditioning has been in use longer than either residential or commercial air conditioning and is being adapted to an increasing number of processes. A list of industries which have adopted air conditioning would include the following: ammunition, candy and confections, cereal and food products, film, leather, paper, pharmaceuticals, plastics, printing and lithography, textiles, tobacco, aircraft components, cameras, communications, electronics, optical goods, vitreous ware, precision equipment, blast furnaces, dye works, explosives, gases, heavy chemicals, rayon, rubber, antibiotics, bakeries, biologicals, breweries, distilleries, and meat packing. In addition to the above, where air conditioning is important to the industrial process, other factories are finding air conditioning of practical value in increased worker efficiency and in procurement of employees.

The above data have been presented to show the tremendous potential of increased air conditioning. As to the effect this air-conditioning load will have on the water works industry, water-cooled air conditioners require, on the average, from 1.5–2.0 gpm per ton of operating capacity. The exact amount depends on the temperature and character of the water. Where the water is hard, mineral encrustation of the cooling coils produces an insulating effect which results in higher water requirement for installations that have been in service any length

of time. The average summer operating requirement is about 1,000 hr which, spread over a 4-month period, means operating an average of 8 hr a day.

Assuming a 3-ton residential, water-cooled installation, the average water requirement at 2 gpm per ton would be 86,400 gal per month. This is approximately 15 times the average winter water consumption for the same residence. By installing a water-conserving device, such as a cooling tower and recirculating the water, the requirement can be reduced to 5 or 10 per cent of the above. Even at 95 per cent reduction—the maximum that can be achieved—the water use for air conditioning will still approximately equal the winter water usage of the same residential customer. It therefore becomes apparent that the water air-conditioning load, without water-conserving devices, could become prohibitive for most water systems. Even with water-conserving devices, this will impose tremendous increased loads in water use.

In a study made of the water requirements of Kansas City, Mo., in 1954, it was estimated that if no restrictions were placed upon air-conditioning water usage, the city would experience a maximum day water demand, in 1970, of 459 mgd. This was compared with an estimated maximum day demand of 208 mgd in 1970 if all air-conditioning equipment were equipped with water-conserving devices. The maximum day demand in 1953 was 123 mgd and by 1955 had already exceeded 155 mgd.

Restriction

Three methods of restricting air-conditioning water usage have been effected: by ordinances prohibiting installation and operation of non-conserved air-conditioning equipment; by application of a demand charge for water usage in nonconserved equipment and by restricting, through ordinance or high sewer service charges, the amount of water discharged into the sanitary sewer system. The latter method, however, is not always effective in curtailing water usage because the waste water in many cases can be discharged to storm sewers. The decision as to which of the above restrictive methods is most desirable depends upon several factors, the most important of which is the availability of water supply. Of nearly equal importance is the ability of the water department to finance the system expansion required to meet the demand.

Where water supplies are adequate, the general policy has been to provide any quantity of water required, but to establish a charge for air-conditioning water which covers the cost. The end result is very nearly the same as that achieved through a prohibitive ordinance, because the air-conditioning rate, if realistic, is very nearly economically prohibitive.

The load factor for nonconserved air-conditioning use is so poor that a high demand charge is essential. The high air-conditioning use is applicable to about 1,000 hours per year, and during those hr the systems of the future must be capable of supplying demands over twice what they would be if there were no air-conditioning load. During the other 7,760 hr of the year, therefore, the extra capacity of the system is not needed. The 1954 water study made for Kansas City, Mo., previously mentioned, showed that the water demand exerted by nonconserved air-conditioning equipment constituted 23 per cent of the overall system maximum day demand, and the annual water usage by

this equipment was only 7.3 per cent of that of the total system. Now, 2 years later, the percentage figures are undoubtedly higher and more widely spread.

Even in Michigan, where cooler climate has made air-conditioning development somewhat slower, the effect of air conditioning on water demands is reaching serious proportions. A recent study made in Grand Rapids shows the air-conditioning load to exert 22 per cent of the city's maximum day demand while constituting only 4 per cent of the total yearly consumption.

In St. Louis County, W. Victor Weir (*1*) found that the summer water consumption varied from 5½ to 7 times as much as winter consumption in residences where nonconserved air-conditioning equipment was installed, while the summer to winter ratio in residences of comparable size and location where there was no air conditioning was only 1½ to 1. His findings in commercial installations indicated quite comparable ratios.

The cost of providing complete water system facilities—supply, treatment, transmission, and distribution—at today's costs will run from $700,000 to $1,000,000 per 1 mgd of capacity. If no water restrictions are imposed on air-conditioning use, tremendous expenditures in system expansion will be required. These expenditures would be for facilities required to serve equipment operating less than 12 per cent of the time and using from 5 to 10 per cent of the total water sold, but which would constitute from ¼ to ½ of the total system capacity.

Surcharge

Weir (*1*) has shown that, based on present day installation cost and the ratio of air-conditioning to other water use, his company would be entitled to a surcharge for nonconserved air-conditioning equipment of $60 per ton per year. However, because water rates are not based on replacement or present day costs, he showed that on a load factor basis alone, and using the existing rate for water, a surcharge of $41.97 per ton per year could be justified. Accordingly, the Missouri Public Service Commission authorized a surcharge of $40 per ton per year which will become effective in May 1957.

In Pine Bluff, Ark., the General Water Works Corporation, obtained authorization from the Arkansas Public Service Commission for a surcharge of $12.50 per year per ton of refrigerating equipment installed for air-conditioning use. In Kansas City, Mo., a surcharge has been established which, for commercial air conditioning, will increase from $5.00–$20.00 per ton per year from 1956 to 1959 and, for residential air conditioning, will increase from $2.40–$9.60 per ton per year over the same period. There are undoubtedly numerous other instances where surcharges for water use in nonconserved air-conditioning equipment are in effect.

The AWWA recognized the potential problem several years ago and published a recommended ordinance in 1950 for regulating water use in air conditioning. Since that time, the number of cities which have adopted some form of restrictive ordinance, special charge, or departmental regulation has increased so rapidly that it is impossible to keep current the list of such cities. In Nov. 1955, Frank Amsbary Jr. (*2*) reported that, of 235 cities which had responded to a questionnaire, 53 had instituted restrictions by inhibiting ordinance, 27 had restricted usage through special charges,

92 had adopted department or company regulations aimed at restriction, and 63 had no control at all. In Sep. 1955, *Public Works* magazine reported that of 635 cities which had responded to a questionnaire, only 78 had placed limitations on air-conditioning water use (*3*). Now, a year later, the number of cities with water restrictions on air-conditioning use is undoubtedly much greater.

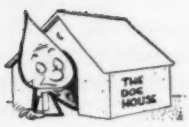
In Michigan the problem has not been as fast in coming as in more arid and hotter sections of the country. However, as evidenced by the situation at Grand Rapids, the problem is now reaching serious proportions.

Conclusion

It is imperative that each community with a public water supply system determine whether use of nonconserved air-conditioning equipment should be prohibited or whether it should be restricted through application of a special charge. Certainly, one or the other action should be taken to assure a system of capacity adequate to meet all needs, and to place the cost for system expansion (occasioned by nonconserved water use) directly on the users responsible for the needed expansion.

References

1. Weir, W. Victor. Surcharge for Nonconserved Air Conditioning in St. Louis County. *Jour. AWWA*, **47**:1091 (Nov. 1955).
2. Committee Report. Charges for Residential Air Conditioning. *Jour. AWWA*, **47**:1088 (Nov. 1955).
3. Anon. Restrictions on Water Use for Air Conditioning. *Public Works*, **86**:9:156 (1955).



Inspecting and Testing Stationary Chlorine Storage Facilities

J. L. Burnett and Charles P. Roddy

A contribution to the Journal by J. L. Burnett, Supt. of Purification, and Charles P. Roddy, Chief Chemist, both of Water Dept., Tampa, Fla.

IN May 1953, the Tampa Water Department, Tampa, Florida, put into service its stationary chlorine storage tank. The unit, mounted on pipe lever type tank scales, is 38 ft long with an inside diameter of 7 ft 1 in. and a shell thickness of 47/64 in. It has a circular steel housing which contains two liquid chlorine withdrawal valves located on the longitudinal axis and two gas withdrawal valves on the transverse axis, with a safety valve in the center of the housing. Approximately 300 tons of chlorine passed through the tank in almost 3 years without any major operational difficulties.

In preparing for the first inspection and test, a tank car of chlorine was spotted on the siding parallel to the stationary tank. When the tank was empty, the tank car was put on the line to feed the chlorinators while the storage tank was out of service during the inspection. When the stationary tank was empty, dry air was introduced through one of the angle valves and the tank was blown off through a grid system until the effluent was chlorine free. (The grid system consists of a series of perforated pipes located in the bottom of one of the mixing basins.)

Inspection and Test

With the tank at atmospheric pressure, all lines were disconnected and the safety valve removed. It was then completely filled with water through one of the angle valves and was kept alkaline at all times with soda ash. After the tank was filled, it was allowed to run to the sewer for about 1 hour. The test pump was connected, a hydrostatic pressure of 300 lbs was applied, and the inlet valve was shut off, and the pressure held for 1 hour and recorded. There was no drop in pressure, indicating that no weakness had developed in the tank.

The pressure was removed and water siphoned out through one of the angle valves on the housing. The manhole cover plate was removed and the tank blown out several hours with dry air to insure sufficient oxygen content before anyone entered the tank. While the operators worked inside, they used gas masks at all times and were attended by another man on the platform with a rope and safety harness. All safety precautions were taken when anyone entered the tank.

The interior was scrubbed and hosed down and the water and sludge withdrawn with a siphon. All traces of scale were removed and the tank was partially dried with rags followed with an introduction of dry air until the tank was completely dry. A final inspection was made for corrosion, cracking and pitting and the surface was found to be in very good condi-

tion and ready to be put back in service.

The manhole cover plate was replaced and the studs were inspected before they were replaced. Reconditioned angle valves, the safety valve, and new gaskets were installed and all gages tested. The chlorine producer did all the valve maintenance work on an exchange basis which assured good equipment at a minimum of expense.

Dry air was introduced into the tank and pressure was held at 150 psi for 24 hr while all joints and fittings were checked for leaks. No drop in pressure was found. The tank was blown down and all studs on the manhole cover plate were rechecked. The chlorine remaining in the tank car was transferred to the stationary unit which was then put back on the line to feed the chlorinators as soon as enough of the liquid chlorine had evaporated. During the few hours of unloading, a 150 lb cylinder of chlorine was connected directly to the chlorinators to furnish the feed until the stationary unit was back in service.

Conclusion

After three years on the line, the stationary unit did not present any particular operational difficulties. The outcome of the 3-year inspection and test indicated that a systematic schedule could be set up on a 5-year basis instead of the 2- or 3-year periods originally planned.

Reprints Available

Reprints of the following articles, published in the JOURNAL during the preceding year, will be available from the Association in small quantities, at the prices noted, until the present stock is exhausted. Order by reprint number and author's name from: Order Dept., American Water Works Assn., Inc., 2 Park Avenue, New York 16, N.Y. **Prepayment required on orders under $2.** (Note: This list does not include specifications and similar documents kept permanently in stock.)

Reprint No.	Author	Title	Issue of JOURNAL	No. of Pages	Price per Copy
398	TASK GROUP REPORT	Fluoridation Census, 1954 Supplement	Dec 55	7	20¢
601	BURNETT, LEWIS	Tests of Coatings	Feb 56	21	35¢
606	DAVIDSON	Electrical Inspection of Coatings	Feb 56	10	25¢
602	INGRAM, CRABILL, SILVEY	Infestations in Water Systems	Mar 56	24	35¢
603	PANEL DISCUSSION	Lawn-sprinkling Load	Apr 56	17	30¢
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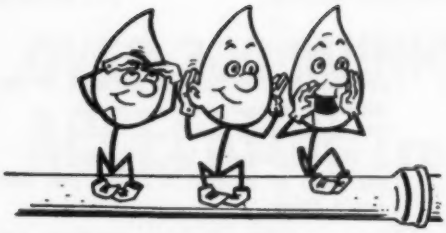
617	BARRETT	Galvanic Corrosion in Meters	Oct 56	8	25¢
618	CARNS	Service and Meter Sizing	Oct 56	7	25¢



Percolation and Runoff

All the Water You Need, When and Where You Need It!—our proposed slogan for water utilities—is making its debut on a section meeting program at Indianapolis this month. Well—almost—for somehow or other our exclamation point got twisted into the shape of a question mark and our "need" was expanded to "want." With Harry Jordan, Blucher Poole, Hy Gerstein, and Mel Hatcher the panelists involved, we're certain the query will be straightened out before the session is over, and if it's "want" they want to satisfy, so much the better. Meanwhile, the phrase, *with* the exclamation point, would have been a "natural" as a title for the discussion of the California Water Plan that leads off this issue, for in California more, perhaps, than in any other state, the emphasis, throughout, has been essentially positive—on getting people what they want, rather than getting them to accept less. And it is, undoubtedly, because of that positive approach that Californians are, on the whole, much more ready to face up to paying the price of what they want than are most water customers elsewhere.

It was actually concern over promising to provide water for what might be considered wasteful purposes and a recognition of the water works man's social conscience that led us to select "need" rather than "want" as a proper goal. But with the economic facts of life tending to equate want and need wherever water isn't plentiful, we're not one to quibble. Actually, of course, it will be the customer who decides which—he pays his money, he takes his choice. And, not being at all anxious to decide whether he really needs what he wants, we're more than willing to go along with: "All the Water You Want, When and Where You Want It!"

All the water that we implied wasn't but could be, actually is available in northeastern Oklahoma, and that portion of the state should have been specifically disincluded from our November picture (P&R p. 35) of a droughtbound Oklahoma. Just how good a job that area has done in providing all the water its customers need —rain or no—is described in a letter from Tulsa in this month's Correspondence (P&R p. 94).

Belle jingles have come our way once more from Wabash, Ind., where the Ford Meter Box Co., apparently supported by a Ford Rhyme Box Co., has presented two appreciations of the product that inspires us all—if not to poetry, to some lesser form of expression. Because this is what we've been trying to say right along, we dub these Fords not only jinglers laureate to the

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water works field, but P&Rtists cum laude.

Just Add Water

The words on labels tell this tale,
In recipes, in ads by mail,
And chances are, at work or play,
You'll see these famous words today—
Just add water.

You'd be surprised how many things
Are dry and useless till one brings
The magic liquid known to all;
You use it when you heed the call—
Just add water.

To illustrate and prove this thought,
Remember all the food you've bought
On which was printed, clear and bright,
Instructions that make cooking light—
Just add water.

You now can buy, in many makes,
Dried fruits, or soups, or tasty cakes;
To powdered milk and frozen juices,
To products with a thousand uses,
Just add water.

Imagine for a minute, please,
An arid wasteland, bare of trees;
This could be farmland, rich and good
And quite productive if we could
Just add water.

What turns cement into concrete?
What changes seed to golden wheat?
No other words now known to man
Can answer that; but these words can:
Just add water.

—David J. Ford

●

Put the First Thing First

When we contemplate the blessings of
our modern way of life
We're inclined to think of gadgets that
are new.
But they can take my TV
If only they will leave me
My sure supply of water and the plumb-
ing it runs through.

My modern shiny kitchen is my greatest
pride and joy—
There's a grinder for the garbage in the
sink.
Unless water's there to chase it
We will shortly have to face it
That plain or ground it smells just like
you'd think.

These machines for doing washings are
as automatic as can be—
Just push a button and your weekly
laundry's done.
But don't take any joshing—
It's the water does the washing—
If you don't believe it, try just one dry
run.

My home is air conditioned so it's always
nice and cool
Although I must admit it costs me dear.
But I'd rather have it hotter
Than do without the water.
That keeps us clean and safe throughout
the year.

In our search for modern gadgets which
will make for easy life
Let's not forget the one thing we need
worst.
Though we come to automation
I hope they never ration
The water we should think about in put-
ting first things first.

—John L. Ford

What this Journal needs is two Fords in every issue!

Meter boxes were the source of inspiration at Birmingham, Ala., last month, too, but there, instead of a jingle, it could have been a jag that resulted, when 7 gals. of untaxed moonshine were found hidden in seven water meter boxes in a single city block. Not protection against a January freezeup either—at least of the meters—these gals. were crocked, and with no one to claim or explain them they were whisked off to police headquarters to be killed—destroyed, that is. Thus, another distribution system is undone by a peek.

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Paul Weir was the recipient of an Atlanta Chamber of Commerce Leadership Award at its recent annual meeting. The photo above shows Atlanta Chamber of Commerce President Hix H. Green presenting the award to AWWA President Weir.

The first public hearing on interstate water pollution under the Federal Water Pollution Control Program was scheduled last month before a board appointed by the secretary of health, education, and welfare. Involved are the waters of the Corney drainage system flowing from Arkansas into Louisiana's Corney Lake, a part of the Claiborne Parish land utilization recreational project. The board was to receive evidence on allegations that Arkansas oil wells were discharging acid, salt, and other wastes into these waters, thereby killing fish and other aquatic life and impairing potential industrial use.

What prize water? The Nobel Prize, no less—the 1956 award in chemistry having been given to Sir Cyril N. Hinshelwood, Lee's professor of chemistry at the University of Oxford, and Professor Nikolai N. Semenov, founder and permanent director of the Institute of Chemical Physics, Moscow, for their detailed investigations of the various ways in which oxygen and hydrogen can combine. Having also studied the energy released by these various reactions, they have turned up new information on such matters as the chain reaction fundamental to photosynthesis, which, in confirming our own thoughts about how vital water is, also points up its value in getting East and West together on something really important.

Roy W. Morse, director, Technical Review Staff, US Dept. of Interior, since February 1955, has resigned to accept appointment as city engineer at Seattle, Wash., where he had previously been water department superintendent.

Hubert F. O'Brien, president, A. P. Smith Mfg. Co., East Orange, N.J., has been elected a director of the National Assn. of Manufacturers.

Harold B. Gotaas, formerly director of the Sanitary Engineering Laboratory at the University of California, Berkeley, has been named dean of the Technological Institute, Northwestern University, Evanston, Ill.

John J. Moran, of Franklin Square, N.Y., has been named Neptune Meter Co. sales representative in a newly formed district consisting of six southern New York counties.

(Continued on page 40 P&R)

(*Continued from page 38 P&R*)

Employment Information

Because of a recent large increase in the volume of requests for the publication of employment information, the JOURNAL has decided to change its policy and, on a trial basis, to accept classified advertising under this heading, beginning with the March 1957 issue. Categories will be limited to "Positions Available" and "Positions Wanted."

Advertisements will be printed in 6-point type, and will be charged at the rate of $1.50 per line (minimum charge, $5.00), *payable in advance.* (In calculating charges, assume six words per line, count *each* element of a compound word or proper name as one word, count each word to be printed all in CAPITALS as two words.)

Copy must be received no later than the first of the month prior to that in which the ad is intended to appear (i.e., for March, the deadline is Feb. 1). Copy and payment should be sent to: Classified Ad Dept., Journal AWWA, 2 Park Avenue, New York 16, N.Y.

Auburn, Ala., is in need of a water works superintendent. Applicants should write fully to: Chairman, Water Works Board, Auburn.

A mongoose and snake tale with a reverse twist was enacted at Woodbridge, N.J., last month, when the mongoose came out second best. Of course, it was competition rather than

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combat and the snake was made of steel, but the story managed to keep even New York *Times* readers interested for more than a week. The problem was one of threading a fire-warning system wire through a 730-ft length of 4-in. pipe under the New Jersey Turnpike. Having kept the public entertained with 10 days of rat runs, pneumatic fish lines, and various other animals and gadgets, the fire department finally enlisted the aid of a pet mongoose, named Pops, who made a practice run through the pipe with ease. Wired, however, Pops pooped out after 300 ft and, thus, brought the Utility Service Co. into the picture with two 400-ft steel snakes, one with a grapple, the other with a knob at the end. Getting together halfway through the conduit, the two snakes made a monkey out of the mongoose by completing the mission on first try. All of which probably proves that water works men need not worry about mongooses on the loose in their distribution systems. What we can't figure out, though, is why someone didn't think of letting water do the job. With a float and a piece of cord, the business could have been all washed up in no time at all—and if it was drama they wanted, they could have brought a goldfish into the act—or if Pops were a weasel! After all, there is such a thing as wire-to-water efficiency!

EJC installed Joseph W. Barker (of ASME) as president and Fischer S. Black (of AIEE) as vice-president at the close of its General Assembly on Jan. 18.

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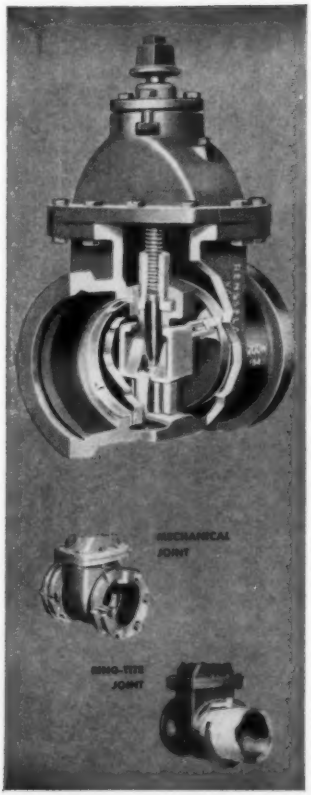
Thorndike Saville has retired as dean of New York University's College of Engineering, a position he has held since 1935. During his tenure of office, the college formed a Graduate Div. and a Research Div., and the fields of sanitary science, meteorology and oceanography, engineering physics, and nuclear physics achieved major status. Dean Saville's retirement from the college will enable him to devote more time to acting as a consultant in the fields of water supply, hydrology, and coastal engineering.

The Olympian brew that sustained those gods and goddesses of athletic prowess who represented the United States at the Olympic Games last year while on their way to Melbourne was 975 gal of the "purest drinking water made, purged of all lint, soot, rust, and microorganisms—though not of mineral content." Provided by Canada Dry, Inc., as a means of protecting our athletes against the ill effects of changing water several times en route, this "neutral nectar" (pH 7.0) apparently worked—perhaps even too well, for there were at least two or three of the long-distance events in which our boys could have done with a little more running. Be that as it may, the appreciation of stability in water quality by athletes may well be the first step in their appreciation of water quality as such. And if *they* appreciate water, we're in! Just imagine the sensation if Mickey Mantle were to say: "It's the filtered taste I like in water." Or if Floyd Patterson were to confess: "I insist on gargling only free-residual-chlorinated water between rounds!" Even Olympus couldn't have been more wonderful!

(Continued on page 84 P&R)



A. W. W. A.

VALVES

It costs more to dig up a valve than it does to be sure that the valve is right in the first place. Rensselaer A.W.W.A. Valves have been giving satisfactory service in hundreds of cities for many years, and there are many "reasons why."

The well known Rensselaer wedge mechanism, for instance, presses the gates firmly against the valve seats on closing, but on the first turn of the opening, the wedging mechanism is released and the gates are free.

The generous use of solid bronze, the rust proofing and the simplicity of servicing make for long life and low maintenance. All parts are interchangeable and accurate because of the precision casting and machining.

Only two types of valve ends are shown. All types are available together with tapping valves and other accessories.

The names, Ludlow and Rensselaer mean the same today that they have during your lifetime. The desire to serve the Water Works Field in person —in research and design and in prompt delivery of original equipment and spare parts for all products has not changed. On the other hand, our ability to serve has at least doubled.

16

LUDLOW & Rensselaer

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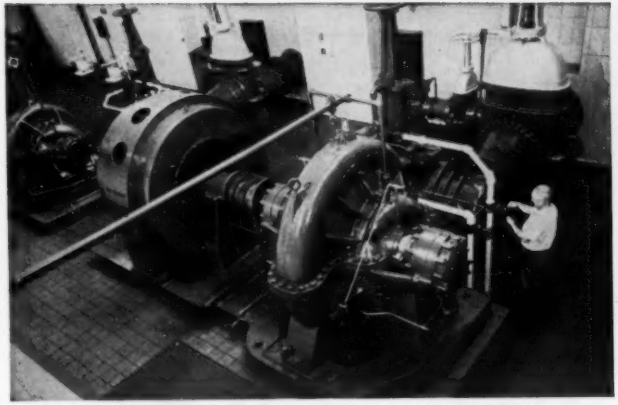
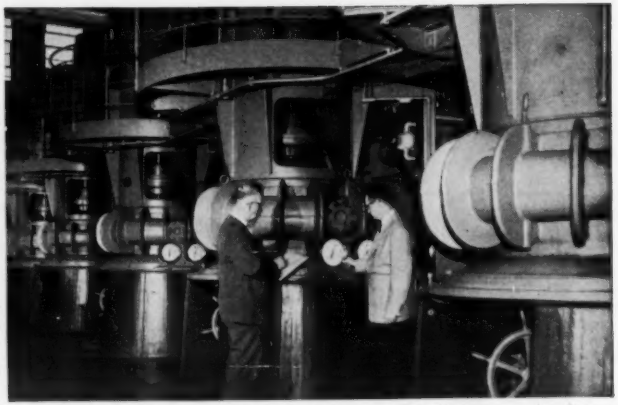
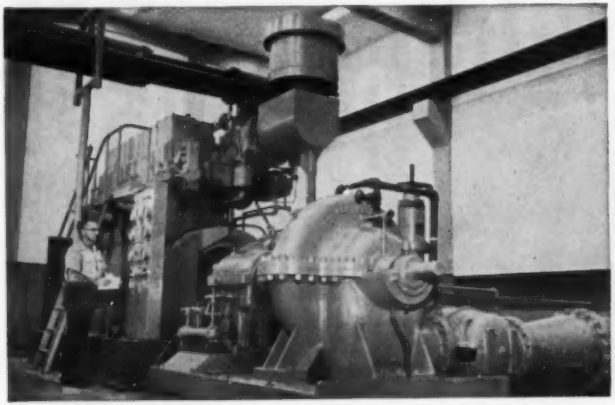


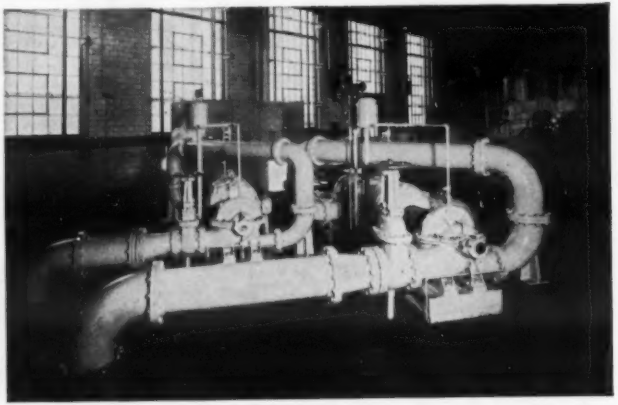
PHILADELPHIA, PA. One of ten Worthington high lift centrifugal pumps at the Torresdale Pumping Station. Capacity of this pump is 40 MGD.



NIAGARA FALLS, N. Y. Worthington high lift pumps in the Water Filtration Plant. In all, there are ten Worthington pumps, 15 to 30 MGD each.



MIAMI, FLA. One of four Worthington 15 MGD pumps driven by a Worthington diesel engine at the new Alexander



SHARON, PA. Two Worthington two-stage centrifugal pumps at the Sharon Valley Water Company. Capacity of

driven by a Worthington diesel engine at the new Alexander

pumps at the Sharon Valley Water Company. Capacity of

The Reading Meter

The Future of Arid Lands. *Gilbert F. White, ed. Pub. No. 43, American Assn. for Advancement of Science, 1515 Massachusetts Ave., N.W., Washington 5, D.C. (1956) 453 pp.; $6.75*

This volume consists of papers by scientists from seventeen countries assessing current efforts to make productive and stable use of the "arid" regions that comprise a third of the world's land surface. Presented at the International Arid Lands Meetings in New Mexico in spring 1955, the papers describe the present state of knowledge and the need for new research on water supply variability and predictability, improved resources utilization, and prospects for additional water sources. Emphasis is placed upon the desirability of integrated analysis of regional resources problems and the advantages of joining archeologic with hydrologic studies, or botanical with climatological and geomorphic studies.

Studying Your Community. *Roland L. Warren. Russell Sage Foundation, 505 Park Ave., New York 22, N.Y. (1955) 385 pp.; $3*

If there is any merit to the proposition that creating a water utility–minded public requires civic-minded utility officials, it follows that the latter should be concerned with such aspects of community life as economic conditions, growth and planning, housing, education, recreation, welfare services, health, and group relations. This book does not, of course, provide answers, but it tells what questions to ask in each of these fields. The text is designed to afford a framework of meaning for the questions by explaining some of the issues they raise and by referring, where appropriate, to widely accepted standards for community appraisal. Thus the book can serve as a practical orientation for community studies.

Principles of Industrial Waste Treatment. *C. Fred Gurnham. John Wiley & Sons, 440—4th Ave., New York 16, N.Y. (1955) 399 pp.; $9.50*

Instead of dealing with waste treatment industry by industry, Prof. Gurnham discusses each of the principal methods separately and shows how each is applied in treating wastes from different industries. Most of the material is devoted to treatment operations and processes before discharge into natural waters and sewers. The author describes pretreatment, the various types of physical, chemical, and biological treatment, and final disposal. Also covered are the sources of wastes, their pollutional effects, and a brief review of major industry problems. Intended as a college text, the book is made particularly useful by the "unit operations" approach.

Applied Thermodynamics [*Formerly "Heat Power"*]. *Earle B. Norris, Eric Therkelsen & Clarence E. Trent. McGraw-Hill Book Co., 330 W. 42nd St., New York 36, N.Y. (1955; 3rd ed.) 462 pp.; $7.50*

The primary purpose of this text is to provide an understanding of the fundamentals of thermodynamics as applied to power generation. The topics dealt with include internal-combustion engines, steam

(*Continued on page 52 P&R*)

The Reading Meter

(Continued from page 50 P&R)

power, condensers, boilers, and refrigeration. Among the new developments covered in the third edition are those involving dual-fuel diesel engines, gas turbines, nuclear power, and compressors.

American Standard Scheme for the Identification of Piping Systems—ASA A13.1–1956. *Am. Soc. of Mechanical Engrs., 29 W. 39th St., New York 18, N.Y. (1956) 8 pp.; paperbound; $1*

It is recommended that pipe be labeled by lettered legend to indicate the material carried—for example, "raw water," "finished water"—with an arrow showing the direction of flow. For supplementary information, either lettering or color (applied over the entire pipe or as bands) is suggested. Color alone is not regarded as suitable for identification because it is subject to fading, as well as obliteration, and there are not enough distinct hues for the large number of materials now carried in pipelines.

Legal Problems in Engineering. *Melvin Nord. John Wiley & Sons, 440—4th Ave., New York 16, N.Y. (1956) 391 pp.; $7.50*

Written by an engineer who is also a practicing lawyer, this book is a survey of the law from the engineering viewpoint. Basic fundamentals are covered, as well as such topics as public utilities, construction contracts and specifications, and stream pollution. Because the treatment of these subjects is general in nature, most of the problems peculiar to the water works field are not included.

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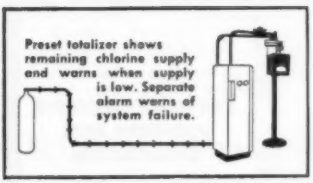

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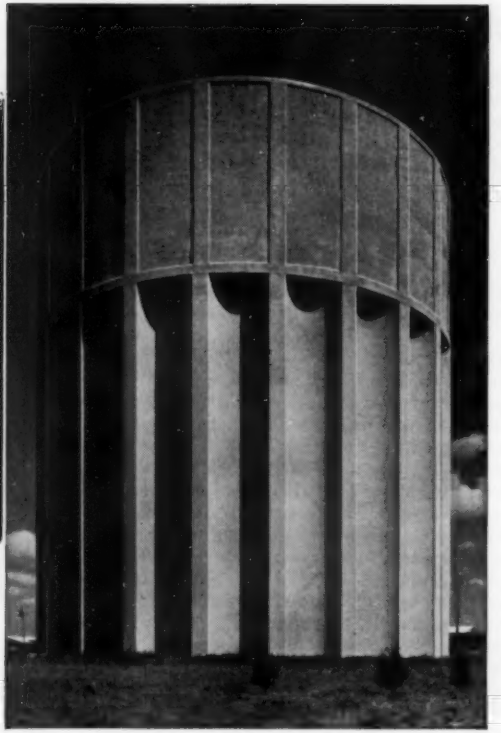


This unique 2,000,000 gal. water tank, located in Casa View Heights, serves Dallas, Tex. It is built of prestressed concrete. Designed by Karl Hoefle, Superintendent of the Dallas Water Department.

Condensation

Key: In the reference to the publication in which the abstracted article appears, **39**:473 (May '47) indicates volume 39, page 473, issue dated May 1947. If the publication is paged by the issue, **39**:5:1 (May '47) indicates volume 39, number 5, page 1, issue dated May 1947. Abbreviations following an abstract indicate that it was taken, by permission, from one of the following periodicals: *BH—Bulletin of Hygiene (Great Britain); CA—Chemical Abstracts; Corr.—Corrosion; IM—Institute of Metals (Great Britain); PHEA—Public Health Engineering Abstracts; SIW—Sewage and Industrial Wastes; WPA—Water Pollution Abstracts (Great Britain).*

BACTERIOLOGY

Comparison of Coliform Group Organisms With Enterococci From Well Waters. C. RITTER, I. F. SHULL, & R. L. QUINLEY. Am. J. Public Health, **46**:612 (May '56). Samples from 595 wells in Kans. were tested for organisms of coliform and enterococcus groups. Data showed there was positive association of these two groups of bacteria; the chi-square test indicated nonindependence with probability less than 0.001. Enterococcus test was found most useful for those wells with coliform values low or fluctuating. Atypical strains of enterococci were isolated from well samples of good sanitary quality as measured by coliform test. Results indicate that test for entire enterococcus group is to be preferred to one for *Streptococcus fecalis* only. Importance of good well construction was shown by these studies. Drilled and driven wells yielded waters of better sanitary quality than dug wells.—*PHEA*

Bacteriological Survey of Auckland Harbors IV. Manukau Harbor. G. M. WALLACE, L. E. NEWMAN, & J. L. JERROME. New Zealand J. Sci. Technol., **37**:663 (May '56). Geometric means and range of coliform organisms as well as plate counts at 37° and 22°C are given. At low tide much of harbour consists of exposed mud flats and dye tests were made to plot flow in channels. It was apparent that not much diln. of wastes occurred in some sections where heavy poln. was noted.—*PHEA*

Survival of Coliform Organisms in Pacific Ocean Coastal Waters. I. NUSBAUM & R. M. GARVER. Sewage and Ind. Wastes, **27**:1383 (Dec. '55). Authors report on studies of viability of coliform organisms in saline water. They conclude that sea water is not antagonistic to coliforms because of its salinity alone. In their experiments, organisms were found to survive for relatively long periods in sea water. They suggest that more data are needed comparing effects of waste dispersal in fresh as well as sea water.—*PHEA*

The Time Factor in Relation to the Bacteriological Analysis of Water. E. W. TAYLOR. Proc. Soc. Water Treatment and Examination, **1**:35 (Dec. '52). Paper discusses importance of time between collection and setting up of sample in lab. and time before opinion can be given on bact. quality of water after tubes and plates have been inoculated and put into incubator. When 52 samples of well water were examined within 2 hr of collection and again after 18 additional hr, the coliform and *Bact. coli* were reduced by holding. Similar test by 7 laboratories scattered through England and Wales used samples from surface and underground sources. Of 151 samples of water stored overnight at room temp. 23 showed significant increase in presumptive coliform count and 29 showed a significant decrease; corresponding figures for storage overnight in refrigerator for coliform count were 10 and 26. Third series of tests using surface and ground water were made and did not show significant changes for samples stored overnight in either refrigerator or at room temperature. Divergent results could not be explained; however, there was suggestion that surface waters might differ from ground waters. Second part of paper did not reveal any means for shortening time necessary to establish that water was free from coliform organisms, but if coliform organisms appeared they could be confirmed or otherwise as *Bact. coli* within 24 hr of setting up of sample.—*PHEA*

Survival of Enteric Organisms in Sea Water. A. E. GREENBERG. Public Health Rep., **71**:77 (Jan. '56). This paper is a review of literature on several factors that

(Continued on page 66 P&R)

Water Testing

*APPROVED Water Pollution Control Technique

in the Laboratory

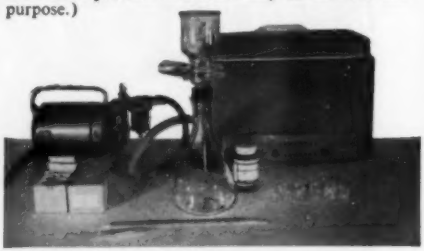
WHEN LABORATORY FACILITIES ARE AVAILABLE, and large numbers of samples from local sources are to be examined, it is recommended that conventional MF® laboratory equipment be employed. Dehydrated MF® Endo medium may be purchased from the Difco Laboratories, Detroit 1, Mich.; Baltimore Biological Laboratory, Inc., Baltimore 18, Md.; or Albimi Laboratories, Brooklyn 2, N. Y. , U.S.A. MF® Endo media should be freshly mixed according to the manufacturers' directions. (Figure 1.)

Millipore Filters and Absorbent Pads are available in resealable Kraft bags. They should be properly autoclaved in the bags as received, for a period not to exceed 15 minutes at a temperature not to exceed 121°C. (Figure 2.)

ABSORBENT PADS ARE THEN PLACED IN INDIVIDUAL PETRI DISHES. Plastic Petri Dishes or ointment tins of the proper dimensions may be employed. Approximately 1.8 ml of Endo media is added to each pad (cover the dishes and put them to one side). (Figure 3.) Filters are placed on the filter holder base using alcohol-flamed forceps, and the funnel is centered and locked. (Figures 4 and 5.) A water sample of an appropriate size is then poured into the funnel and passed through the Millipore Filter into the filter flask by the aid of vacuum (Figure 6.)

The filter disc is then removed with sterile forceps and carefully placed on the absorbent nutrient pad in a petri dish with a "rolling action" to avoid trapping air between the filter and nutrient pad. (Figure 7.)

PETRI DISHES ARE INVERTED AND INCUBATED for 20 hours at 35°C. (Figure 8.) In potable waters it is not necessary to sterilize filter holders between samples. A 20 ml rinse of the funnel walls with sterile water is sufficient. (The water in the filter flask from previous filtrations may be used for this purpose.)



MATERIALS REQUIRED FOR 100 TESTS

Supplies: 100 (one pkg.) HA White Grid 047mm Autoclave Packed Filters. (Absorbent pads are included.)
10 grams Dehydrated MF® Endo Medium (or equivalent).

Equipment: 1Pyrex Filter Holder or Hydrosol Simplified Filter Holder. (Stainless Steel)
1 Vacuum Pressure Pump.
100 (one pkg.) Plastic Petri Dishes (or equivalent).
1 Field-Laboratory Incubator (or equivalent).
1 10 ml. pipette. 1 Pyrex Filter Flask (1 liter).
1 Pair Stamp-Type Forceps. 1 Magnifier 6X to 15X.

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The Sanitarian provides himself with a Sanitarian's Kit consisting of an all-metal syringe, valve, and sample cup. These need not be sterilized.

A SAMPLE OF THE PROPER SIZE IS TAKEN in the stainless steel cup. The cup must first be thoroughly rinsed in the same water from which the sample is to be taken. (Figure 1.) The syringe valve and sampling tube are plugged into the Field Monitor (they won't assemble incorrectly). The syringe plunger is drawn back and held to pull the sample up through the Field Monitor. (Figure 2.) Large samples may require several strokes. Monitors must be held upright to draw the last few drops from the filter. (Figure 3.) The plastic sampling tube is then removed and discarded.

THE TIP OF AN AMPUL OF MEDIUM IS BROKEN and the ampul is inserted into the Monitor (Figure 4.) The top of the ampul is then broken and the ampul lifted very slightly to allow the medium to flow into the Monitor. (Figure 5.) A partial stroke of the syringe will draw the medium through the filter. (Figure 6.) It is important to STOP pulling on the syringe the INSTANT the last few drops of the medium disappear from the filter surface. The protective caps are then replaced. (Figure 7.)

THE FIELD MONITOR IS INCUBATED for 20 hours at 35°C. (Figure 8.) If desired, the Monitors may be replaced in their boxes and forwarded to a central laboratory for incubation. Special holding media may be substituted for Endo media if shipping delays over 48 hours are expected. Naturally, samples can be held for only short periods in excessively high temperatures (42°C or over). Some organisms will not withstand such temperatures whether in sample bottles or in the Field Monitor units. In an emergency, Monitors may be incubated in the field by placing them next to the body for 20 hours.

MATERIALS REQUIRED FOR 100 TESTS

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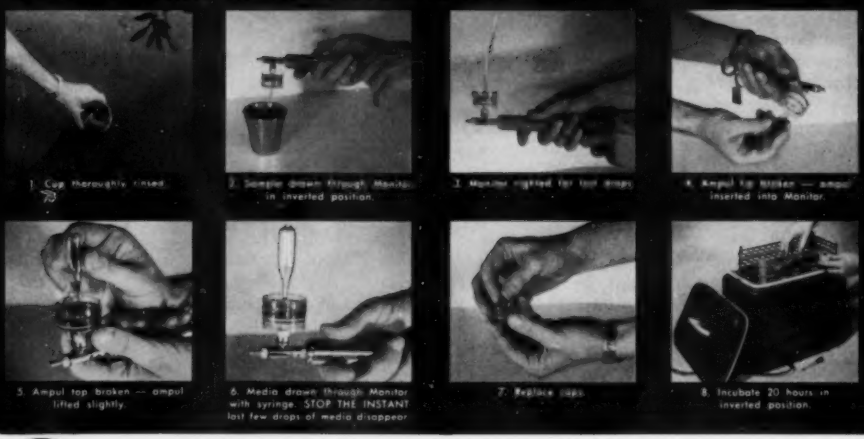

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(*Continued from page 62 P&R*)

influence survival in sea water. Presence of inorganic salts, toxic substances, bacteriophages, antibiotics, and predators are considered as well as effects of adsorption, sedimentation, sunlight, temp., aeration, and food supply.—*PHEA*

The Survival of Coliforms, *Streptococcus faecalis* and *Salmonella tennessee* in Soil and Climate of Israel. S. B. RABINOWITZ. Bul. Research Council Israel, **4**:205 ('54). Investigations on survival in soil of coliform bacteria, *Streptococcus faecalis*, and *Salmonella tennessee*, showed that initially there was marked reduction in numbers in terra-rossa soil irrigated once with sewage. *Salmonella* continued to decrease and had disappeared from surface by 46th day and from lower levels in soil by 70th day. Numbers of coliform bacteria decreased to a relatively stable pop. which then showed no change with time. An investigation was also made in summer in which *Salm. tennessee* was added to crude sewage kept in open storage tanks commonly used in irrigation in Israel. Part of sewage was applied to uncultivated plots. *Salmonella* disappeared from surface of soil by 15th day. Coliform organisms and *Str. faecalis* persisted throughout experiment which lasted 38 days. *Salmonella* survived for up to 22 days in storage tanks. *Salm. tennessee* survived for up to 23 days at surface of sewage-irrigated soil used for growing sunflowers. Judging by rate of disappearance from soil, *Str. faecalis* does not appear to be preferable to coliform bacteria as indicators of faecal poln.—*WPA*

The Bacteriological Survey of Wellington Harbor. Extent of Pollution Spread Northwards From the Ngauranga Outfall. J. K. JOHANNESSON & R. E. MARTIN. New Zealand J. Sci. Technol., **37**:445 (Jan. '56). Poln. survey of Wellington Harbor was continued into area north of Ngauranga outfall and extending nearly to the Petone foreshore. 50 sampling stations were established, and each was stamped on each of 5 runs made, confirmed *E. coli* counts were derived, and contour maps were prepared. It was found that Ngauranga outfall does not influence northeast end of harbor; what poln. exists there comes from local sources. Wind is dominant factor in dispersion of poln. No sewage field was found in Evans Bay.—*PHEA*

Influence of Aminocarboxylic Acid Lactams on Microorganisms in Water and Biochemical Processes in Self-purification of Water. T. I. ROGOVSKAYA. Microbiology (USSR), **23**:464 ('55). Studies on influence of acid lactams on microorganisms in water have shown that, in concns. up to 1 g/l, they have no effect on color, saprophytic activity, odor or pH value of river water or domestic sewage. They do not specifically affect saprophytic bacteria in concns. up to 10 g/l. Caprolactam was found toxic to *Serratia marcescens*, *Aer. aerogenes*, and *Pseudomonas fluorescens*, in concns. of 40 g/l or more. Some organisms, however, used caprolactam as nutrient material. Effect of lactams on biochem. processes in self-purification of water is discussed, with special reference to caprolactam. Up to concn. of 1 g/l, caprolactam has no effect on simple organisms, and oxygen system in open ponds, and is not toxic to phytoplankton and algae. To prevent interference with self-purification processes, it is recommended that limiting concn. of caprolactam should be 0.1 g/l.

Technique for Microscopic Count of Microorganisms Directly on Membrane Filters. R. EHRLICH. J. Bacteriol., **70**:265 (Sep. '55). Technique is described for quant. detection of microorganisms in liquid media. Liquid is filtered through a membrane filter leaving bacteria on filter where they are stained. Stained cells are counted directly on membrane filter with aid of light microscope.—*PHEA*

Estimation of Coliform Density by the Membrane Filter and Fermentation Tube Methods. H. A. THOMAS JR & R. L. WOODWARD. Am. J. Public Health, **45**:1431 ('55). Statistical analyses of results of 3 extensive investigations on wide variety of natural waters comparing MPN and MF techniques indicate that, on avg., former gives higher indications of density by factor of 1.1 to 2.0. This is not regarded as significant from practical viewpoint because of inherent lack of precision of individual MPN value. Considerable part of disparity is due to fact that MPN tends to overestimate true density. Precision of density estimates made from examining single MF is 2–5 times greater than that from a 5–5–5 tube MPN.—*PHEA*

(*Continued on page 68 P&R*)

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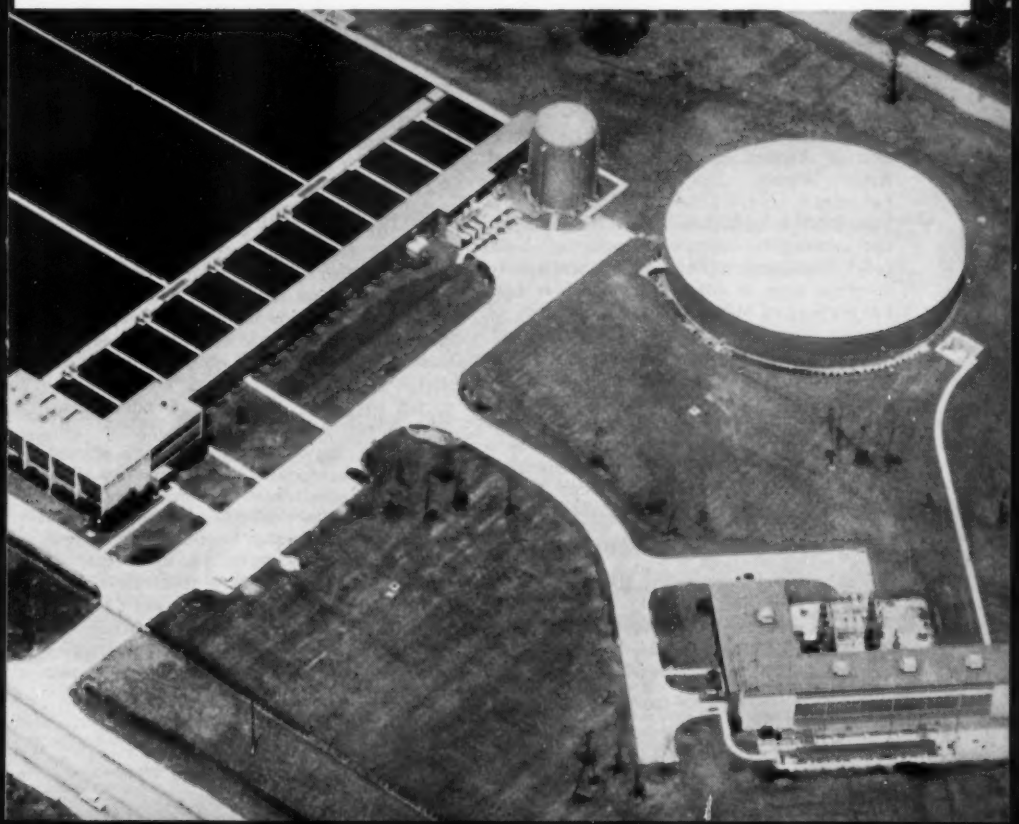


(*Continued from page 66 P&R*)

Statistical Analysis of Coliform Data. H. A. THOMAS. Sew. Ind. Wastes, **27**:212 ('55). Statistical anal. of results of detn. of MPN of coliform organisms in pold. water has shown that arithmetic mean coliform density gives more accurate est. of poln. than do other commonly used avgs. such as geometric mean and median. To allow for inconclusive fermentation results, the observed MPN's should be plotted on log-probability paper and arithmetic mean density calcd. from curves obtained. From curves it is also possible to calc. geometric std. deviation, which indicates fluctuations in coliform density. It is suggested that existing stds. for coliform content of effluents might be improved by basing them on arithmetic mean coliform density.—*WPA*

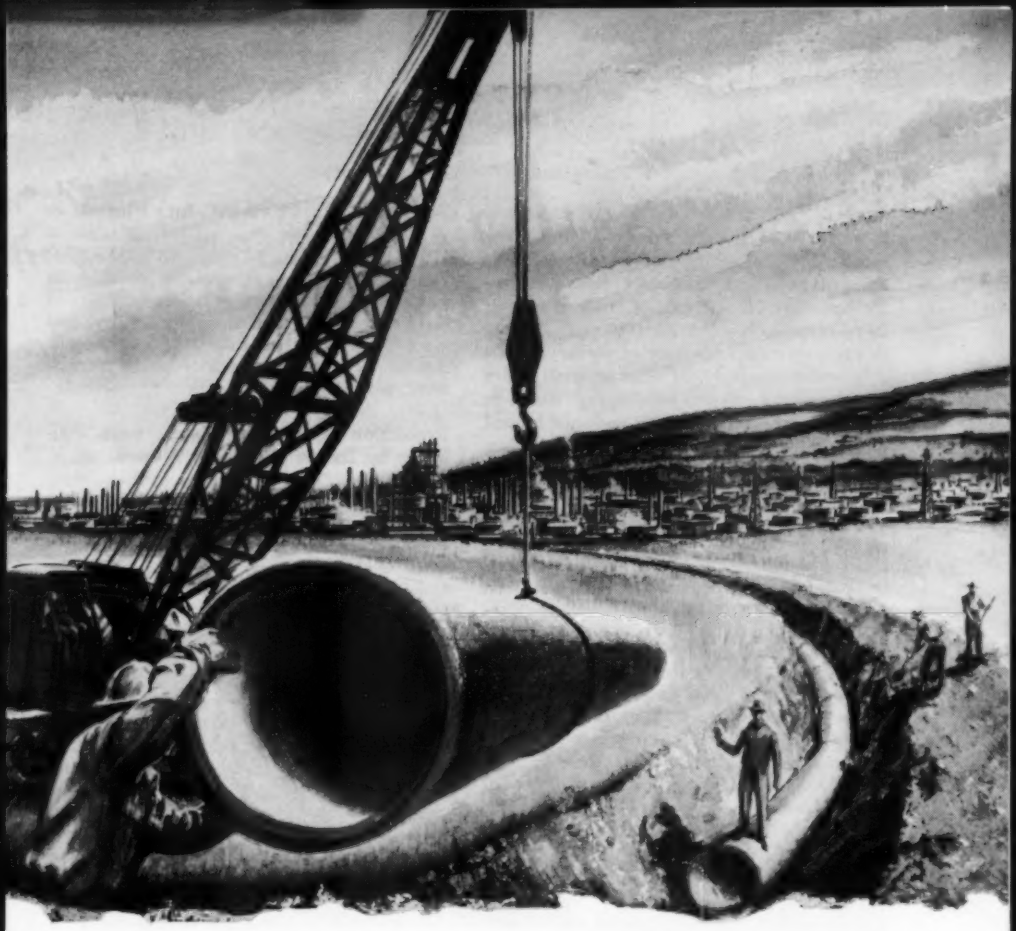
Instrumental Estimation of Bacterial Population by Fluorescence Microscopy. R. EHRLICH & H. C. EHRMANTRAUT. Appl. Microbiol., Baltimore, **3**:231 ('55). Method is described for quantitative estimation of bacteria, based on quant. detn. of intensity of fluorescence emitted by bacteria stained with fluorochrome coriphosphine. Uniform and reproducible results can be obtained if amber-colored rigid vinylite slides are used instead of conventional microscope slides.—*WPA*

Comparative Examinations of the Detection of *Escherichia coli* in Drinking and River Water. T. EMMENEGGER. Mitt. Lebensm. Hyg. (Swiss), **46**:415 ('55). Fermentation of lactose-contg. bouillon does not necessarily indicate presence of *Esch. coli*. Small amt. of the bouillon was spread on Endo agar or eosin-methylene blue agar for purpose of identification. Superiority of formate-ricinoleate bouillon was evident. Coli titer was detd. by Eijkman and Buir's fermentation test or by membrane filter method. Same titers were found by both methods in drinking water while, for river water, membrane filter method proved to be better. 4 different kinds of bouillon were tested, best one being mixt. of lactose bouillon with formate-ricinoleate bouillon.—*CA*

POLLUTION CONTROL

Recent Developments in the Control of Stream Pollution. B. A. SOUTHGATE & A. L. H. GAMESON. Surveyor (Br.), **115**: 349 ('56). Authors discuss various aspects of the control of poln. which have been developed recently. In the Rivers (Prevention of Pollution) Act, 1951, provision is made for imposition by river boards of byelaws specifying standards of quality of effluents discharged to a river. One such standard would be B.O.D., which is important in determining the concn. of D.O. which will be maintained in river. Normal 5-day B.O.D. test does not necessarily indicate total effect of effluent on stream to which it is discharged, as nitrification may occur shortly after discharge, presumably because of presence in river of active nitrifying bacteria, and ratio of ultimate oxygen demand to 5-day B.O.D. varies widely; for effluents in which no nitrification takes place during 5-day incubation period, it is greater for those from biol. treatment plants than for settled sewage. Condition of a river to which polg. matter is discharged depends not only on amt. of oxidizable matter discharged, but also on rate at which oxygen is dissolved from air. This varies according to depth and nature of stream, and experiments have shown it to be much greater for turbulent streams than for nearly stagnant water. It is therefore important to take nature of stream into consideration when predicting quantity of polg. matter which can be discharged to it without lowering concn. of D.O. below some predetermined value. Distribution of oxygen in a river is also affected by deposition of insol. org. matter in reaches immediately below outfall, causing rapid reduction in oxygen concn. in short zone of river. Recent increase in use of domestic synthetic detergents has had important effect on sewage treatment and on streams to which sewage-works effluents are discharged. Most obvious effect of synthetic detergents in sewage works is production of foam in activated-sludge tanks, and they have also been reported to reduce efficiency of purification. Experiments have shown that residual surface-active material remaining in effluent after treatment is slightly toxic to fish, though the concn. used in these experiments was much higher than concn. normally found in rivers. It has also been found that synthetic detergents markedly reduce rate at which oxygen is absorbed from air by de-oxygenated water, and further work on this problem is necessary. Surveys carried out by Water Poln. Research Lab. on estuaries of Tees, Mersey, and Thames have shown

(*Continued on page 70 P&R*)



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(*Continued from page 68 P&R*)

that capac. for self-purification of estuary is much more limited than has often been supposed. This is because material discharged to estuary normally remains there for considerable period of time, so that large proportion of ultimate oxygen demand is exerted within confines of estuary, while only water available for diln. is fresh water entering from river, which may itself be pold., and sea water which has only limited capacity for dilg. org. matter. In addition, an estuary is normally deep, so that oxygenation from air is slow. If water in an estuary contains only a small percentage of saturation value of oxygen, no evolution of hydrogen sulfide will occur, but if remaining oxygen disappears, hydrogen sulfide may be produced. It is recommended that in estuaries in which concn. of oxygen is approaching critical level, a survey be made at least once each year, preferably after long dry spell when conditions in estuary are likely to be worst, so that necessary remedial measures can be undertaken before anaerobic conditions develop. Considerable work has been carried out during past 30 yr on treatment of various types of trade waste waters, and studies are now in progress on anaerobic digestion of strong organic waste waters, such as those from slaughterhouses.—*WPA*

Fundamentals of the Control and Treatment of Dairy Waste. H. A. TREBLER & H. G. HARDING. Sewage and Ind. Wastes, **27**:1369 ('55). Authors review composition and treatment of waste waters from milk trade. Present trend is towards large plants equipped to utilize all byproducts and reduce volume of waste. Waste waters are strongly polg., and show marked seasonal, daily and hourly variations in vol. and strength. Importance of segregating different types of waste water and of providing preliminary treatment of floor wastes for separation of grit and fat, is stressed. Wherever possible, discharge of waste waters to municipal sewers is preferable. Disposal by irrigation is frequently used. High-rate biol. filtration gives good results, but activated-sludge process is cheaper and simpler to install. In activated-sludge process it is important to maintain temperature at 80–90°F and to provide good agitation with aeration devices that do not encourage foaming.—*WPA*

Fly Ash as Adsorbent for Phenol in Waste Waters. R. RIEDL, J. MACAK & M. BENES. Paliva (Czech.), **35**:260 ('55). Lab. experiments on removal of phenol from waste waters by adsorption on fly ash showed that ash from combustion of brown coal more adsorbent than ash from black coals. Activity of ash could be increased by treatment with dil. hydrochloric acid.—*WPA*

Protection of Surface Waters from Pollution by Industrial Waste Waters. S. N. CZERKINSKI. Stattsverlag fur Medizin, Moscow, 1954 (In Russian). Literarurber Wasser, Abwasser Luft u Boden (Ger.), **4**:98 ('55). Account is given of investigations, made under Ministry of Public Health of Russia, into permissible concn. of toxic and other harmful materials in surface waters. Investigation covered not only toxic effects but also effects on sanitary and organoleptic properties. 13 investigators examined 30 toxic and otherwise harmful materials and 27 separate reports are presented, dealing with composition of materials examined, their stability during progress of biol. self-purification, their toxicity, and their hygienic and organoleptic properties. Table is given of most important substances, their permissible concns., and decisive tests. Standards proposed have been adopted as legally binding.—*WPA*

Contribution to the Study of Dephenolation and Purification of Waste Waters from Coke Works. H. GUINOT & X. TINCHANT. Chimie & industrie (Fr.), **75**:1304 ('56). Method for treatment of phenolic waste waters from coke and gas works involves chlorination under acid conditions. This results in formation and pptn. of trichlorophenols, which are only sparingly sol. in water. Small amount of trichlorophenol remaining in soln. can be extracted with org. solvents such as benzene. Trichlorophenol produced can be used in production of synthetic plant hormones and to stimulate synergistically fungicidal action of pentachlorophenol.—*WPA*

Control of Metal Plating Rinse Waters. J. B. MOHLER. Industrial Wastes, **1**:77 (Nov.–Dec. '55). Automatic control of metal plating rinse water is resulting in savings of 50 to 90 per cent of amt. of water previously used. Plating rinse waters in-

(*Continued on page 74 P&R*)

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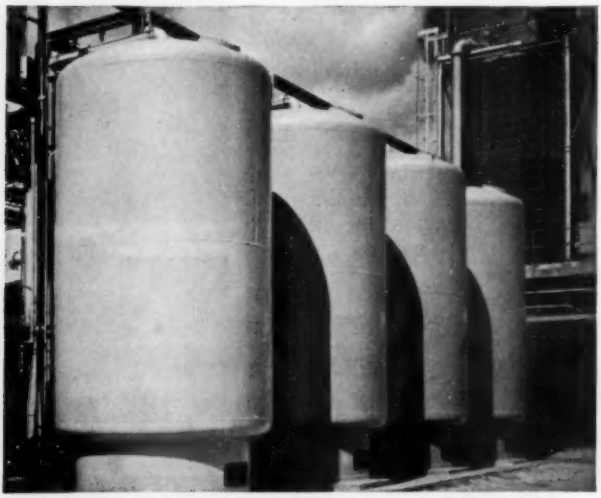

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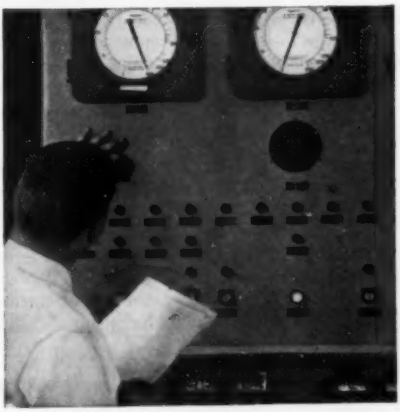

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(*Continued from page 70 P&R*)

crease in concn., and hence conductivity, due to drag-in of chems. by work. Conductivity controller turns water off and on in response to detected changes in conductivity and is very sensitive in dil. solns. Thus conductivity of rinse water can be held to a narrow preset range.—*PHEA*

Stream Biota and Stream Pollution. C. B. WURTZ. Sewage and Ind. Wastes, **27**:1270 (Nov. '55). An interesting method is described for presenting data on biota of a stream graphically as series of histograms which may be used to interpret stream conditions with regard to poln. All living organisms found in stream are categorized into 4 basic life forms described as: [1] burrowing organisms, [2] sessile organisms, [3] foraging organisms and [4] pelagic organisms. Each river station is represented by a 4-column histogram in which each column includes all organisms which share basic life form. Histogram is projected above and below baseline with that portion of each column above the baseline representing non-tolerant organisms and part below baseline representing tolerant organisms. Columns are plotted as a frequency index in which total number of species found at any station represents a frequency of 100 per cent for that station, and thus, total area within any one histogram equals 100 per cent. Interpretation of stream condition is derived from relative proportion of non-tolerant to tolerant species and structure of pop. histogram that results from plotted data for each river station. In general, stream may be considered clean-water stream when nontolerant species represent more than 50 per cent of the total pop., and normal, clean-water station may be expected to have relative proportions of the pop. composing each column of life forms of approximately 5 per cent, 40 per cent, 45 per cent, and 10 per cent, respectively. Examples of method, employing actual stream data, are given.—*PHEA*

Estimating Stream Pollution Survey Costs. L. G. RICH & D. A. JONES. Sewage and Ind. Wastes, **27**:1279 (Nov. '55). Rational method for computing costs of stream poln. surveys is described. Fixed and per-sample costs of chems., depreciation of apparatus, and labor requirements are presented in tabular form for 32 different laboratory tests.—*PHEA*

Report of the Water Pollution Research Board With the Report of the Director of Water Pollution Research for the Year 1955. DEPARTMENT OF SCIENTIFIC & INDUSTRIAL RESEARCH. H.M. Stationery Office, London ('56). (Copies may be purchased from British Information Services, 30 Rockefeller Plaza, New York 20, N.Y.) Much of drainage area of London County Council is sewered on combined system, and at times of heavy rainfall, storm water is discharged directly to Thames estuary either by pumping from low-level sewers or by gravity from high-level sewers. Attempt has been made to determine quantity of oxidizable matter entering estuary in storm-water discharges. In general, vol. of storm water increases linearly with rainfall, but there is no exact relation as vol. discharged depends on intensity of rainfall rather than on total rainfall. Analyses of large number of samples of storm water showed it of very variable quality. Avg. results of anal. of samples of pumped storm water were B.O.D. 221 ppm, permanganate oxygen demand 152 ppm, and suspended solids 706 ppm. Avg. composition of samples from gravitational storm reliefs was B.O.D. 99 ppm, permanganate oxygen demand 54 ppm, and suspended solids 339 ppm. When storm-water overflows are discharging, polg. load they contribute to estuary will represent considerable proportion of total polg. load, particularly as about half the storm water enters estuary above London Bridge, where there is comparatively little diln., and it must therefore be major factor in determining the concn. of oxygen in this part of river during periods of heavy rain. Measurements were made of rate of discharge of effluent from Northern Outfall sewage works of London County Council, which is one of major sources of poln. of estuary. Avg. dry-weather flow was estimated to be 178 mgd. Effect of rainfall on flow was determined, and it was found that avg. discharge in excess of dry-weather flow was 320 mil gal per inch of rain. Flue gases from Battersea and Bankside power stations are washed with water from estuary, and this is returned to estuary after aeration. Oxygen demand of these effluents has been calculated to be only small proportion of total demand from other sources, but effect of

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washing water is more pronounced than that of org. discharge with same oxygen demand, as sulfite in washing water is oxidized very rapidly after discharge to estuary. Lab. studies were made to determine effects of various factors on exit coefficient of oxygen. Rate of absorption of oxygen was found to be less in sea water and brackish water than in fresh water, and was reduced by presence of sewage-works effluent, settled sewage, or synthetic detergents. Effect of synthetic detergents was found to be less marked in water already containing sewage-works effluent than in clean water. Some experiments were also made to determine combined effects of poln., temp., and salinity, and estimates of exit coefficient were made from consideration of total oxygen balance in estuary from Teddington to Southend. Method was developed for calculating present distribution of temp. in estuary resulting from present discharges of heated effluents. This method can be used to predict changes in distribution of temp. with changes in fresh-water flow at Teddington, and also to predict further changes which would occur as result of alterations in input of heat. *Oxygen Balance in Fresh-Water Streams.* Work has begun on variations in concn. of dissolved oxygen in pold. fresh-water streams, with view to obtaining data from which can be predicted effect on oxygen content of stream of any given effluent discharged to it. Before an oxygen balance can be drawn up, it is necessary to know rate at which given stream, containing certain concn. of oxygen, will absorb further oxygen from air. First experiments on this problem were made on an unpolluted stream in Lake District. Exit coefficient was determined, and effects on it of anionic surface-active agents were investigated. Some observations were also made on river Lea, where photosynthetic and respiratory activities of plants were found to have greater effect on oxygen balance than either bact. oxidation or reaeration from atmosphere. Exit coefficient was also determined in small stream flowing into river Lea after passing through watercress bed. Exit coefficient in this shallow placid stream was found to be much greater than avg. value in Thames estuary, where surface waves are much larger but depth much greater. At night concn. of D.O. fell to almost 4 ppm, due to respiration of plants and animals and to oxidation of decomposing vegetation and mud. *Effects of Pollution on Fish.* Under Rivers (Prevention of Pollution) Act, 1951, River Boards are empowered to prescribe standards of quality for effluents discharged in their areas, and in some areas at least these may include standard limiting toxicity of an effluent to fish. Ministry of Agriculture, Fisheries, and Food intends to set up lab. in London where routine tests of toxicity of effluents can be made, and studies are now in progress to develop suitable standard test. Test will probably be made by observing periods of survival of fish in several dilns. of effluent. Species and size of test fish must be specified, and it will be necessary to control temperature, pH, and concn. of D.O., as these factors all affect toxicity. Most work so far has been concerned with methods for controlling the concn. of D.O. at level close to air-saturation value. Most sensitive Br. fish are brown trout and rainbow trout, but vol. of effluent required to test these satisfactorily would be too large to be easily transported, and studies are being made on sensitivity of number of small species of foreign fish. Apparatus has been devised in which toxicity tests lasting several weeks can be made under controlled conditions of pH, temp. concn. of D.O., and concn. of 1 or more poisons. Experiments are being made on effect of temp. on survival of trout and of several species of coarse fish in low tensions of oxygen. Results so far obtained confirm that rise in temp. between 10°C and 21°C decreases resistance of fish to lack of oxygen. Of species tested, trout were most susceptible and tench most resistant. Some experiments were made to determine approximate toxicity of chief substances which are mixed with anionic surface-active agents in proprietary synthetic detergents. Most toxic constituent tested was alkylolamide of a fatty acid, but all ingredients were very much less toxic than surface-active agent. As it is possible that some change may occur in chem. composition of detergents during passage through sewage works, synthetic sewage to which synthetic detergents had been added was passed through pilot-scale percolating filter, and toxicity of effluent to fish was compared with toxicity of tap water containing same concn. of surface-active agent as effluent.

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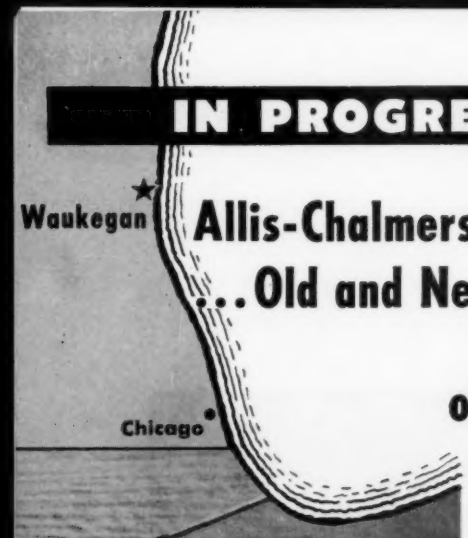
IN PROGRESSIVE WAUKEGAN



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On the shore of Lake Michigan, just north of Chicago, is Waukegan, Illinois, a busy industrial center and home of more than 70 thriving concerns manufacturing over 400 varied products.

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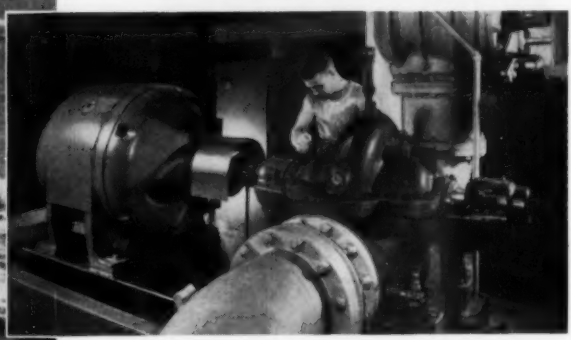
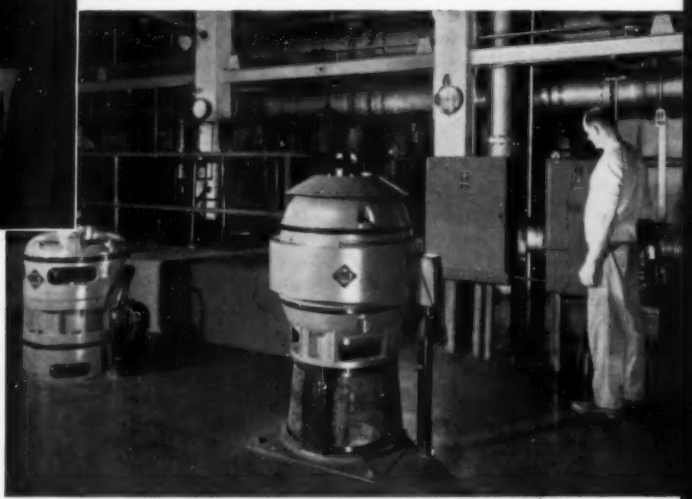


Newly installed Allis-Chalmers horizontal high lift, 7½-mgd, 220-ft head pump, driven by Allis-Chalmers 350-hp, 1170-rpm motor, with Allis-Chalmers control panel.

ALLIS-

Overall view of Waukegan Water Works pump floor, showing Allis-Chalmers pumps, motors, control, and switchgear handling high lift, low lift and wash water service.



New Allis-Chalmers vertical drip-proof motor (right), drives the Allis-Chalmers low lift pump shown in the photo above. Motor is rated 100 hp, 1170 rpm. Pump is 12 by 12 vertical type, delivering 7½ mgd against a 55-ft head. The control also is manufactured by Allis-Chalmers.

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A-5214

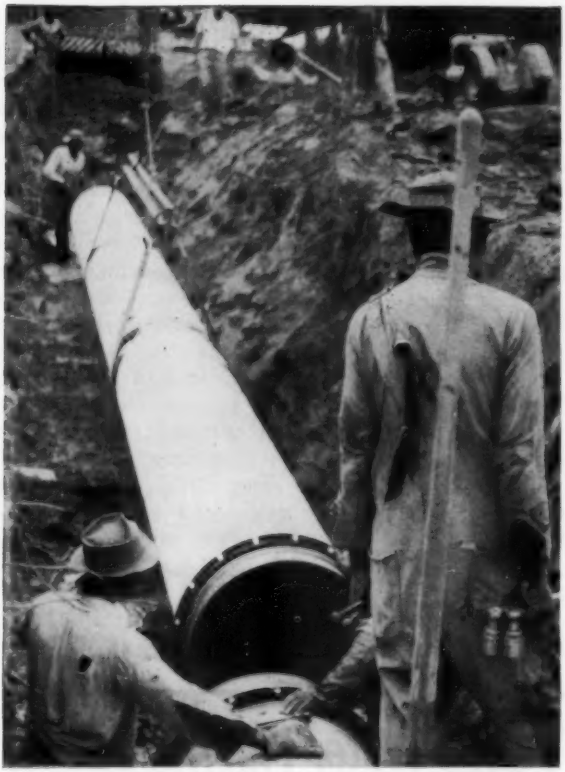
(*Continued from page 76 P&R*)

Toxicity of detergent was found to be greater in tap water than in sewage effluent. Presence of synthetic detergents, even in concns. as low as 1.8 ppm was also found to increase susceptibility of trout to low concns. of oxygen. In river pold. by sewage-works effluent, ammonia is always likely to be present, and experiments have also shown that combined effects of synthetic detergents and ammonia are greater than toxicity of either alone. After completing survey of the river Colne, lab. experiments were carried out to determine sensitivity of various species of fish to conditions which prevailed at different times in effluent channel through which sewage effluent was discharged to river. It is pointed out that this survey was made with undiluted sewage-works effluent, and if such an effluent were diluted with 4 or 5 times its vol. of clean water, toxicity of mixture would be negligible, and death of fish in such mixture would be due only to lack of oxygen. *Sewage.* It has been calculated that, for percolating filter treating sewage at rate similar to that usually employed, flow of air through medium equivalent to 30 cu ft per cu yd per day should be sufficient to provide oxygen required. Anals. of air from centre of filter showed that concn. of oxygen was only slightly less than that in atmosphere. Some preliminary experiments were made to determine effect on operation of filter of reducing concn. of oxygen in interstitial atmosphere. It was found that although efficiency of filters decreased slightly with decrease in oxygen concn., this had no great effect either on proportion of org. carbon removed or on amt. of carbon oxidized, but onset of nitrification was retarded by reduction in oxygen concn. and was almost completely inhibited when air contained only 2 per cent oxygen. Filters all contained approx. same total wt. of biol. film, but greater proportion of film occurred near top of filter containing normal air than in filters containing less oxygen. Ponding in filter is often due to excessive growth of fungi near surface of medium. It might be possible, by changing method of operation, to control relative proportions of fungi and bacteria in the biol. film. Experiments were made, using typical bacteria and fungi found in filters, to determine their efficiency in oxidizing org. matter. The "economic coefficient," calculated as ratio of dry wt. of growth to corresponding wt. of glucose destroyed, was much lower for 2 zoogloeal bacteria examined than for 4 species of fungi. Most rapid destruction of glucose was achieved by fungus *Geotrichum* and zoogloeal bacteria. Considerable reductions in numbers of coliform bacteria in sewage have been observed during sedimentation and biol. filtration, and some experiments were made to ascertain whether these reductions were due to action of bacteriophage. Samples of sewage were treated with toluene to kill large proportion of bacteria without affecting bacteriophage, and were then plated with a phage-sensitive strain of *B. coli.* No significant increases in numbers of bacteriophage or in proportion of resistant bacteria occurred, indicating that bacteriophage is not main cause of reduction in numbers of *B. coli.* Synthetic sewage containing mixture of 7 proprietary synthetic detergents, equivalent to 26.5 ppm was passed through small-scale percolating filter, and results compared with those from filter treating sewage without added detergent. When first applied, little detergent passed through filter, probably because of adsorption by biol. film, after 3 wks, 30-40 per cent of detergent was being removed, and after 13 wks. 60–70 per cent was being removed. The results showed that this concn. of detergent caused slight, but significant reduction in efficiency of filter. Some observations were made on performance of new alternating double filtration plant at Bedford, which is designed to treat an avg. dry-weather flow of 2.5 mgd. When the flow exceeds 1.5 times dry-weather flow, plant changes automatically to operate by single filtration. Satisfactory results of operation were obtained during period of observation. Effect of prolonged storage of standard diln. water on results of B.O.D. test was investigated. *Industrial Waste Waters.* In previous experiments on treatment of cyanide waste waters in percolating filters, rate of application of waste waters and depth of filters were based on normal sewage-treatment practice. Experiments have now been carried out using deeper filter of correspondingly smaller diam. Almost complete removal of cyanide was achieved when 68 ppm cyanide was applied at rate of 150 gal per cu yd per day, and about 70 per cent of nitrogen was oxidized. When concn. of cyanide was increased to 83 ppm, applied at the same rate, efficiency of filter deteri-

(*Continued on page 82 P&R*)

(*Continued from page 80 P&R*)

orated, but this might have been caused by factors other than concn. of cyanide. Waste waters from slaughterhouses and meat-processing plants are highly polg., and contain blood, fats, guts, and stomach contents, and watery extracts from cooking processes. Experiments are in progress on treatment of these waste waters, particularly by anaerobic digestion. Preliminary experiments showed that digestion was more rapid at 35°C than at room temp. or at 40°C, and that there was an optimum condition of stirring, as either excessive or insufficient stirring produced an inactive coagulated sludge. Under optimum conditions sludge was light and settled easily. As judged by reduction in B.O.D., efficiency of process was not significantly affected by quite wide variations in org. loading, but condition of sludge deteriorated if load was very low or very high, becoming light in texture at loadings below 400 mg of org. carbon per litre per day, and very sticky at a loading of 700 mg of carbon per l. per day. Average B.O.D. of waste waters before digestion was 2,326 ppm, and B.O.D. of effluent after digestion varied from 100 ppm to 760 ppm; quality of effluent appeared to be related to kind of animal from which waste waters were derived and proportion of blood in waste waters at any particular time. Org. nitrogen was almost completely converted to ammonia, and high concns. of ammonia appeared in effluent. Preliminary experiments indicate that effluent may be amenable to further treatment by biol. filtration. On farms, practice of concreting floors of cattle sheds and washing floors regularly is becoming common, and this leads to production of large vol. of washings, heavily pold. by dung and urine. These waste waters are stronger than domestic sewage and contain high proportion of finely divided suspended solids which do not settle readily. Great difficulty has been experienced when these waste waters were treated in conventional biol. filtration plant, and experiments have been made to find methods of overcoming this problem. It was found that considerable reduction in B.O.D. could be achieved when sample of waste water with an initial B.O.D. of 500 ppm was coagulated with 150 ppm aluminum sulfate, with or without adjustment of pH. However, stronger wastes required as much as 600 ppm aluminium sulfate to give satisfactory coagulation. After diln., coagulated waste waters could be more easily treated on lab.-scale percolating filter than could untreated waste waters. Nature of substances in cattle shed wastes that are resistant to biol. oxidation is being investigated. Complete removal of suspended solids from waste waters caused no change in ratio of B.O.D. to permanganate oxygen demand of remaining liquid, indicating that resistant substances may be present both in solids and in soln. Studies have been made to determine optimum concentrations of chems. required to break particular oil emulsions. Waste waters from washing of aircraft with detergent preparations containing thinning oils and dispersing agents, may contain up to 8 per cent emulsified oil and have permanganate oxygen demand of 1,400 ppm. At least 4,000 ppm each of aluminium sulfate and sulfuric acid were necessary to break such an emulsion. Satisfactory results were also obtained with acid alone and with common salt. Aluminium, ferric, or calcium salts produced very bulky precipitates, unless pH was reduced to 2.6, probably because detergent preparation contained considerable amount of phosphate. Treatment plants are being constructed at airfields where aircraft are washed in this way. Although relatively large quantity is required, it is proposed to use common salt to break emulsion, as it is simple to use, avoids use of strong acid, and does not produce sludge. An investigation was also made of treatment of oily waste waters from engineering shops, which often contain, in addition to soluble cutting oils, caustic liquors used in washing machines for degreasing metal components. *Water.* Experiments have been continued on removal of fluoride from water by passage through activated alumina. It appears that procedure used in regenerating alumina is important in maintaining efficiency of bed. From small-scale experiments it appears that, provided, regeneration is satisfactory, from 1,000 to 2,000 gal of water can be treated to contain less than 1 ppm fluoride per cu ft of alumina, and after first cycle there should be little deterioration in efficiency of bed. It is likely, however, that there is continuous loss of alumina from bed during treatment and regeneration, and it is felt that experiments on larger scale would be necessary to investigate this.—*WPA*



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Speed. Easy-to-install Dresser Couplings require only two man-minutes per bolt, or less; allow joints to be completed in record time.

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(Continued from page 46 P&R)

Waterborne disease, which, among people served by public water systems, has become almost as extinct as the bogey man, occasionally issues a reminder of its past frightfulness. Thus, last summer when 400 delegates to a church camp meeting at Monark Springs, Mo., drank water from a contaminated well, first diarrhea and then typhoid was reported to have broken out among them after they had returned home, leaving at least 3 dead, 12 seriously ill, and another 12 under observation. And up in Ottawa, Ont., when a mild outbreak of typhoid from an unknown cause reintroduced the disease for the first time in 20 years, the local newspaper pointed out that there must now be many doctors in Canada who never had confronted a case of typhoid fever. Meanwhile from strife-torn Budapest came word of amebic dysentery from polluted water, the result of rupture of water mains and sewers in the street fighting there. And, from Argentina, there is the report that 150 cases of cancer have been attributed to arsenic occurring naturally in the drinking water. None of these serves to indict our present standards of water works practice, but rather to remind us of the importance of maintaining and improving them to meet not only the old bogeys, but those present and as yet unborn.

It is the current status of public drinking water safety, no doubt, that explains how people can make money selling home water purification kits at $7.95 each to those not served by

(Continued on page 86 P&R)

ALOXITE® Underdrains solve filter problems for growing Barranquilla

Water consumption in Barranquilla, Colombia, jumped from 8.04 to 19.10 MGD between 1935 and 1950. This created quite a problem for the city's Empress Publicas Municipales. They tackled it by giving experts a free hand to investigate every method and material known in order to give Barranquilla the best water supply system obtainable.

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(Continued from page 84 P&R)

public water supplies, using the "risk of waterborne infection" by "cocci" as a sales pitch. Of course, even some water works men may want to get in line to obtain, at that price, a kit that will remove bacteria, hardness, taste, and odor, or for $9.95, a chlorinator-fluoridator kit (with chemicals), or for $10.95, a 3,000-grain softening kit, or for $24, all three, postpaid, with a money-back guarantee, or for only $3, complete plans and specifications. Even as cockeyed as coccied, safe water seems to pay.

Hagan Corp. has changed its name to Hagan Chemicals & Controls, Inc. Its subsidiaries, Calgon, Inc., Hall Labs., Inc., and Buromin Co., have been merged into the parent company but will continue to operate as divisions.

APHA has announced the election of John W. Knutson as president for the year ending in November 1957. Dr. Knutson is assistant surgeon general and chief dental officer of the US Public Health Service. Named president-elect (for the term beginning in November 1957) was Roy J. Morton, supervisor, Waste Disposal Unit, Oak Ridge National Lab.

James B. Cook Jr. has been appointed sales manager of the General Products Div. of Hays Mfg. Co., Erie, Pa. Mr. Cook came to Hays from C. I. Thornburg Co., Huntington, W.Va., where he was vice-president and sales manager.

(Continued on page 88 P&R)

(Continued from page 86 P&R)

E. Arthur Bell has been appointed general manager of Stamford (Conn.) Water Co., with Valentine O. Ketchum, who has been both president and general manager, continuing in the former capacity. Mr. Bell joined the company in 1955 as chief engineer and assistant to the president.

Ellis E. Bankson, partner in the consulting firm of Ellis E. Bankson & Sons, Pittsburgh, Pa., died Dec. 30, 1956, at the age of 72. A graduate of Milliken and Pittsburgh universities, he was a former partner in Chester Engineers, as well as managing engineer of the Allegheny County (Pa.) Sanitary Authority.

A Life Member of AWWA (joined in 1922), Mr. Bankson also belonged to ASCE, Pennsylvania Society of Professional Engineers, and Engineering Society of Western Pennsylvania.

Howard M. Gifft, professor of civil engineering at Cornell University, Ithaca, N.Y., and dean-elect of the university faculty, died Dec. 20, 1956. He was 48. Born at Muskogee, Okla., he was graduated from Iowa State College in 1932. After serving as an engineer with the Iowa Highway Com. and the US Forest Service, he returned to Iowa State to teach and to obtain a graduate degree. In 1941 he was appointed to the faculty of Cornell, where he became head of the Sanitary Engineering Dept. 10 years ago. He was also a partner in the consulting firm of Bogema, Gifft & Jenkins, Ithaca. Professor Gifft had been an AWWA member since 1943.

(Continued on page 92 P&R)

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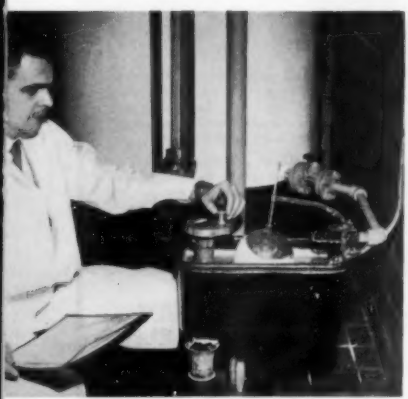

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(Continued from page 88 P&R)

Charles A. Haskins, partner in the consulting engineer firm of Haskins, Riddle & Sharp, Kansas City, Mo., died Dec. 29, 1956, at the age of 69. Born at Galva, Kan., he received a bachelor's degree in engineering from the University of Kansas in 1910 and an M.S. from Harvard in 1914. He engaged in railroad construction engineering, served as chief engineer for the Kansas Board of Health, and was professor of sanitary engineering at the University of Kansas. After World War I, in which he was an Army Sanitary Corps captain, he joined the staff of Black & Veatch, consulting engineers of Kansas City, Mo. In 1922 he entered private practice. From 1934 to 1939 he was chief engineer for the Missouri Building Commission. He formed the firm of Haskins, Riddle & Sharp in 1953. A Life Member of AWWA (joined in 1914), Mr. Haskins was a past-president of the Kansas City Chapter of ASCE and of the Engineering Club of Kansas City, as well as a member of FSIWA (Bedell Awardee).

William H. Lovejoy, superintendent of purification, Louisville (Ky.) Water Co., died Dec. 21, 1956. He was 73. Graduating from Cornell University, Ithaca, N.Y., in 1907, he joined the Louisville Water Co. in 1908. He was a Life Member of AWWA (joined in 1908) and a leader of the Kentucky-Tennessee Section since its inception. In 1954 he received the Fuller Award for his technical contributions to water purification and outstanding service to the community.

Correspondence

All the Water Tulsa Needs

To the Editor:

Referring to your article, "All the Water You Need," in the November 1956 issue (p. 35 P&R), it is true that the rainfall in Oklahoma has been the lowest on record during the past year, and we have had very little rainfall for the past 5 years. However, we have an entirely different picture of water supply in northeastern Oklahoma than was presented in this article. In fact, northeastern Oklahoma has one of the best potential industrial water supplies of any area west of the Mississippi River, and last year the people in Tulsa had "All the Water They Needed." There were no restrictions of any kind and there was no shortage of water.

Northeastern Oklahoma has unusual water resources. We went to Spavinaw in 1924 and built our first lake, for 25 mgd. In 1948 we constructed another dam, Lake Eucha, above Lake Spavinaw, and we now have two flowlines with a total capacity of 65 mgd. By the installation of one pump and using two pumps on this flowline, we will have 80 mgd. We doubled our treatment plant during the past year, added 82 mgd to our pumping capacity, and installed a 48-in. main through our city to storage reservoirs having 27 mil gal capacity.

Our use of water, due to the hot, dry weather and the rapid growth of the city, has increased substantially. Our peak load day last summer was 80 mil gal.

We have agreed on a contract with the US Engineers for storage in Oologah Reservoir that will develop 40 mgd of industrial water. We have a large citizens' committee studying our increased water supply to be completed by 1960. We have made application for industrial water in the Keystone Reservoir west of the city. Our studies contemplate reviewing the possibility of obtaining 150 mgd of water from the Illinois River or from Fort Gibson Reservoir.

The important feature of industrial water lies in the Grand River development. For the last 6 years this river has had an average flow of 4,800 cfs, and at least 1 bgd can be developed on the Fort Gibson Reservoir for water supply. A large number of industries have been locating in the Grand River area on account of the quantity and quality of water available.

In reference to water transportation, all of the reservoirs for the navigation of the Arkansas River from Tulsa to the Mississippi River have been started except two, and the completion of river navigation is contemplated on the Verdigris River up to the area east of the city of Tulsa, which, according to a recently published statement of Major-General E. C. Itschner, Chief of Engineers, Dept. of the Army, can be completed in a minimum of 12 or a maximum of 17 years.

I am sure that the JOURNAL did not have this information when the abovementioned article was written, and in case this article might give a false impression to industries interested in this area, I would like to request you to point

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Correspondence

(*Continued from page 94 P&R*)

out that the potential water supply, water resources, and transportation facilities of Tulsa and northeastern Oklahoma are excellent.

W. F. McMURRY,
Supt. of Water Works & Sewerage

Tulsa, Okla.
Jan. 4, 1957

To correct any possible misimpression occasioned by our original article, we are happy to publish Supt. McMurry's letter and to congratulate the authorities in Tulsa and northeastern Oklahoma for their foresight in providing for an abundant supply.—ED.

Meter Matter

To the Editor:

The October 1956 P&Rticle on "the high bill blues" (p. 50) mentioned the case of the Wright Aeronautical Div., where investigation revealed that some foreign matter had lodged in the measuring chamber of their meter, causing it to overregister.

I would like to know what type of meter was used and how it would be possible for a meter to overregister.

E. J. REEDE

Prineville, Ore.
Dec. 6, 1956

The editors passed Reader Reede's query along to Richard E. Bonyun, general superintendent and chief engineer of the Passaic Valley Water Com., which furnishes Wright's water, and received the following explanation:

The Wright Aeronautical Plant, Wood Ridge, N.J., is located about 10 miles from our distribution reservoir. The company is a very large consumer, using about 5 mgd, with rates of flow up to 8 mgd, which is registered on a 16-in. meter of the turbine type. During the fall of 1955 we experienced a hurricane in this section, and some leaves and straw

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Correspondence

(Continued from page 96 P&R)

blown into our open reservoir must have subsequently been drawn through the outlet bar rack screen and eventually lodged in the cage of the meter.

This was not discovered until months later, when we were investigating the cause of the apparent overregistration. Upon disassembling the meter, we found that the straw and other foreign matter had partially stopped up the openings in the cage, thus forcing the water to flow at higher velocity through the remaining openings and causing the wheel to spin at an abnormally high rate, with resultant overregistration. We have checked with the manufacturer and have been advised that this could happen on a meter of the type involved.

The incident got quite a bit of publicity in the local papers and elsewhere. The matter has since been adjusted satisfactorily to the customer and the commission, and a recurrence is not likely.

RICHARD E. BONYUN

Clifton, N.J.; Dec. 13, 1956

Pine Plantings

To the Editor:

In his discussion on recreational use of reservoirs (November 1956 issue), author Merrill L. Riehl states (p. 1408): "Evergreen planting with its resultant pine needle cushion is desirable for several other reasons: it gives better sheet erosion control, retards runoff of snow and ice, helps sustain stream flow, rehabilitates springs, and reduces loss by transpiration."

There is no doubt that a belt of evergreen plantings around the shoreline is better for water protection than deciduous trees. However, it would be erroneous at the same time to advocate the belief that, in the areas in no immediate vicinity to the water surface, pine plantings are the only desirable ones and that they should be proceeded with even on sites of natural hardwood reproduction. Let us take a brief look at pine plantings and their influence upon the soil: The present approach to watershed management is directed toward finding out how to increase infiltration and storage of water in the soil by improving the soil structure. It is known that pure pine litter is resistant to decay and tends to accumulate at the surface because the type of biological activity under pure pine does not result in incorporation of the litter into the mineral soil; consequently, pines commonly do not produce as deep, rich, or satisfactory humus as mixed pine-hardwood or pure hardwood stands. The type of humus layer present is decisive for the hydrologic characteristics of forest soil; soils where organic material has been incorporated have greater porosity, can store more water, and can transmit it more rapidly than soils where incorporation has not taken place.

It is of interest here to mention the studies at Harvard Forest on different stages of vegetation and their influence on soil. According to these studies, under the planted white pine stand, the soil developed a heavy, raw humus layer which attained a maximum depth of 2 in. in 60 years. After the pine was cut, the hardwoods took over the area. As a result, the raw humus gradually decomposed and was incorporated into the mineral soil, creating an organic layer 6 in. deep. The soil penetration tests during the pine stage showed that, as the stand became older, the soil became more compact, but as the hardwoods came in, the soil loosened up and became friable (US Dept. of Agriculture, Circular No. 910, p. 51).

Such conclusions may serve as a brake on the enthusiasm of men who advocate pure pine stands everywhere on a watershed. And, in conclusion, one more suggestion to those who plant pure evergreen stands: don't forget to employ frequent thinning and to leave the green slash scattered on the ground; this practice will result in the formation of a more desirable form of humus and a consequent increase in storage capacity.

WALTER C. SUSHKO

Baltimore, Md.; Jan. 4, 1957

Section Meetings

North Carolina: The North Carolina Section held its 36th annual meeting at the Hotel Charlotte, in Charlotte, Nov. 12–14, in conjunction with the North Carolina Sewage & Industrial Wastes Assn. [A list of papers presented at the technical sessions appeared on p. 1578 of the December 1956 issue.]

One of the highlights of the meeting was the cocktail party and dinner given on behalf of the Charlotte Water Dept. and an official tour of Charlotte's new Coliseum-Auditorium. Another highlight was the annual banquet, at which William W. Adkins was nominated for the Fuller Award. The Maffitt Membership Cup, awarded annually by the city of Wilmington to the member instrumental in securing the greatest number of new members for the Section, was won for the third consecutive year by Mrs. Ethel G. Young of Raleigh. She now becomes permanent owner of the cup. Alan Newcomb, WBTV radio and television personality, entertained the members and guests with an address on "How to Be Happy Though Educated." Following the banquet, the Association dance was held in the ballroom of the Hotel Charlotte.

Officers elected at the business meeting were: C. W. Mengel—chairman; W. F. Stokes—vice-chairman; W. E. Long Jr.—secretary-treasurer; and R. E. Ebert—trustee.

A most enjoyable aspect of the meeting was the fellowship and entertainment provided by the members of the Water & Sewage Works Manufacturers Assn. For the ladies attending the meeting, there were bridge, a luncheon, a shopping trip, and visits to the Celanese Corp. facilities and to the Children's Nature Museum and Planetarium.

W. E. Long Jr.
Secretary-Treasurer

Rocky Mountain Section: The 30th annual meeting of the Rocky Mountain Section was held at the Broadmoor Hotel in Colorado Springs, Colo., Nov. 27–28. The total registration was 164. Excellent meeting rooms in the Broadmoor Hotel theater were provided by the hotel. The program committee, under the chairmanship of W. F. Turney, of Santa Fe, N.M., prepared a fine program. [A list of the papers presented can be found on pp. 1579–80 of the December 1956 issue.]

The meeting was officially opened with an address of welcome by Major-General Quinn, deputy commander of Fort Carson, who commended all persons in the water works industry for a job well done and expressed the hope that future problems of the arid West can be met. Chairman Jones responded and announced committee appointments.

The business luncheon on Wednesday was attended by 98 members. New business included the passage of an amendment to the by-laws allowing the governing board to name replacements for officers within the Section when necessary owing to transfer or other reasons. The minutes of the 1955–56 meeting were changed to show the election of George Turre as national director. A motion was made for members to consider the community type of entertainment room. Members will be contacted by mail for

(*Continued on page 102 P&R*)

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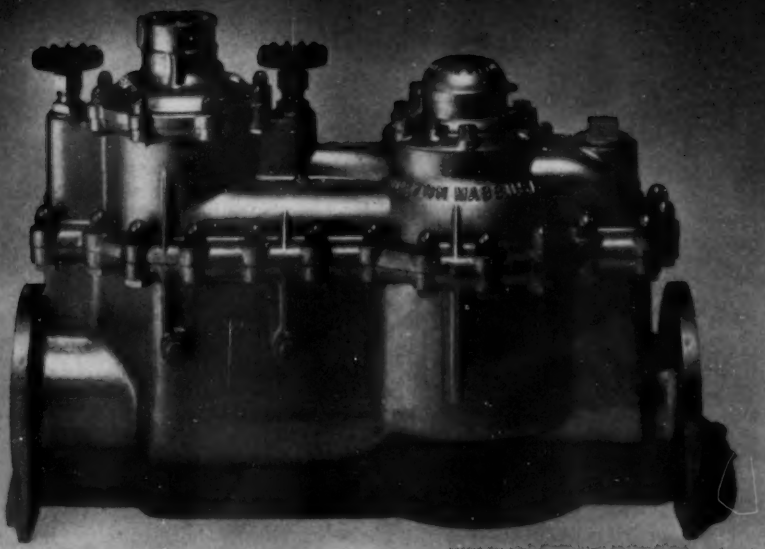

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Section Meetings

(Continued from page 100 P&R)

an expression of opinion and a vote on the matter.

Wednesday evening the banquet was held, with 187 in attendance. After a short series of addresses and an excellent dinner, the El Jebel Shrine hillbilly band entertained the members with a variety show which was a credit to the able entertainment committee, composed of Jay Spencer (chairman), J. S. Nichols, and G. Richard Smith.

Other activities included a fine luncheon and fashion show at the Antlers Hotel, with favors and prizes which delighted the ladies. Credit for these arrangements is due to Mrs. Jay Spencer, Mrs. Orville Jones, Mrs. J. S. Nichols, and Mrs. G. R. Smith. Mrs. Spencer and Mrs. Jones were also hostesses at a get-acquainted coffee for the ladies on Monday morning in the Penrose suite of the Broadmoor Hotel.

The 30th annual meeting was the Section's most successful, with a record number of members in attendance.

JACK W. DAVIS
Secretary-Treasurer

Virginia Section: The 23rd annual meeting of the Virginia Section was held at the Chamberlin Hotel, Old Point Comfort, on Nov. 7–9. Chairman H. F. Knoell, town manager of Orange, presided. The attendance of 233 did not equal the all-time high of 237 but was an excellent showing under the circumstances. The Chamberlin Hotel being on federal government property, which also includes Fortress Monroe, is extensively used by army personnel. With the Egyptian crisis at its height, there were about 100 more army officers in the hotel than had been expected. As a result, several potential Virginia Section guests were turned away.

Of those attending, about 60 were ladies, who were entertained on Wednesday, the first day of the meeting, with a card party at the hotel. On Thursday they enjoyed a bus trip to Williamsburg, 30 miles distant. There were several hours available for sightseeing in this restored colonial capital, broken by luncheon at the Williamsburg Lodge. As has been customary for many years, the ladies all received corsages prior to the banquet on Friday night.

Both the banquet food and the entertainment provided were well above average. There were no speeches, but the chairman introduced all the guests at the head table. Secretary Harry E. Jordan presented a Life Membership certificate to Herman W. Snidow, of the State Health Dept., Richmond. C. Davis Blackwelder, vice-president of Reynolds Metals Co., could not be present to receive his certificate. Old Dominion Awards were presented by committee chairman Bryant L. Strothers to 20-year members. The Virginia Section nominee for the Fuller Award was W. Ray Odor, of Lynchburg Foundry Co., Lynchburg.

The Water & Sewage Works Manufacturers Assn. provided entertainment during the early evenings and at the dance following the banquet on Friday night. The high standard of entertainment at this feature was adequately maintained at this meeting.

Attendance at the technical sessions was particularly good as the result of timely and interesting subjects. [A list of papers presented appeared on p. 1581 of the December 1956 issue.] A departure from the usual technical program routine was a nontechnical talk by W. Harold Bleakley, Northern Div. manager of ABCO, Inc., Erie, Pa. Mr. Bleakley's talk, on accident prevention and safety, brought the largest attendance at any of the technical sessions and included most of the ladies present at the meeting. His inspiring and thought-provoking address was made more effective because of the fact that he is totally blind from two separate accidents.

At the business meeting of the Section there was much interest and a great deal of discussion on expansion of Section activities during the year. The interest centered mainly around cooperation with

(Continued on page 106 P&R)

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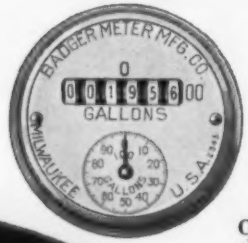

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Section Meetings

(Continued from page 102 P&R)

the State Health Dept., the State Water Control Board, the Virginia Industrial Wastes and Sewage Works Assn., and the faculty at Virginia Polytechnic Institute, to provide instructors and suggestions for curricula at the annual water and sewage works operators short school. It is felt that the value of the school can be enhanced considerably by active cooperation of all of these groups.

Another subject discussed at length was licensing of water works operators. Letters on this matter from the newly organized Virginia Water & Sewage Works Operators Assn. and the Virginia Industrial Wastes & Sewage Works Assn. were read. It was voted to appoint a committee to work with these other groups toward the end suggested.

Officers elected were: W. W. Anders (plant manager, Dept. of Public Utilities, Richmond), chairman; Earl C. Coalson (superintendent, Water Dept., Bristol), vice-chairman; Brent Remsburg (town engineer, South Boston), trustee; and J. P. Kavanagh (Wallace & Tiernan Inc.), secretary-treasurer.

J. P. KAVANAGH
Secretary-Treasurer

West Virginia: The eighteenth meeting of the West Virginia Section was held jointly with the West Virginia Sewage & Industrial Wastes Assn. at the West Virginia Hotel, Bluefield, Oct. 31–Nov. 2. Through the courtesy of the West Virginia Water Service Co., a buffet dinner was given Oct. 30 for the early arrivals at the meeting. About 67 attended the dinner and praised the fine food and fellowship.

The formal meeting opened Oct. 31 with William C. Kell, city manager of Bluefield, making the address of welcome. Inasmuch as this first session was attended by both the water and the sewage groups, the papers presented were of common interest. One covered progress in the control of pollution in the Ohio River, and the other the US Army Engineers' plans for flood control. stream flow regulation, and recreational facilities in West Virginia. At the other sessions of the West Virginia Section, the papers and panel discussions dealt with small water plant construction and operation, rate increase procedure, taste and odor problems, distribution system design, and fluoridation. The highlight was the panel on rate increase procedure, which covered the utility's preparation and presentation, the Public Service Commission requirements, and the legal problems involved. [A list of papers presented appeared on p. 1581 of the December 1956 issue.]

The annual joint banquet was held Thursday evening, Nov. 1, and all present agreed that it was one of the very best, both as to quality of food and as to entertainment. The entertainment ranged from hillbilly music to light opera.

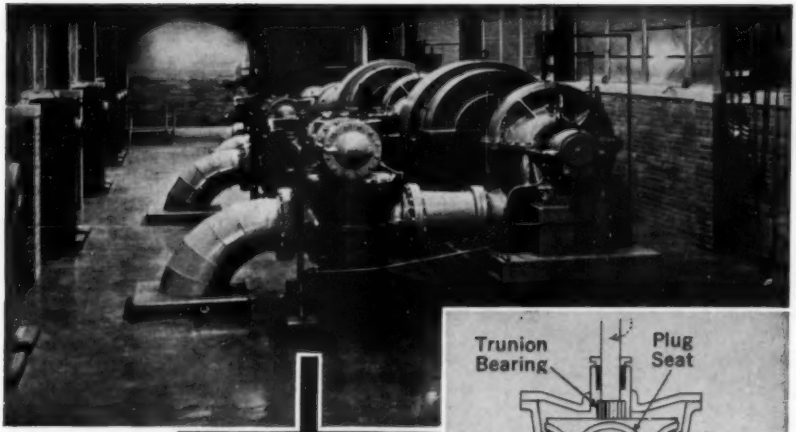
During the meeting, the ladies were entertained with a luncheon and bridge party and an appearance at a television program in connection with a fashion show.

A field inspection trip to the Radford facilities of the Lynchburg Foundry Co. Friday morning, Nov. 2, closed the meeting. To those who chose to go, the trip was very worth while. The company furnished a very good luncheon at the conclusion of the inspection.

At the business meeting the following new officers were elected: chairman—Cecil Coffield, superintendent of water works and sewers, Parkersburg; vice-chairman—Wallace Grant, chemist, West Virginia Water Service Co., Charleston; trustee—Harry K. Gidley, Kelley, Gidley & Staub, Charleston. Hugh W. Hetzer, distribution engineer, West Virginia Water Service Co., Charleston, was reelected secretary-treasurer, and John Millar, chief, Engineering Sec., State Dept. of Health, Charleston, assistant secretary.

The general conclusion of those present at the meeting was that it was one of the best, with the banquet and field trip unusual and exceptional.

HUGH W. HETZER
Secretary-Treasurer



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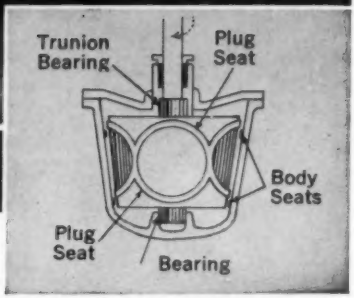

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NEW MEMBERS

Applications received Dec. 1–31, 1956

Adamson, J. Ray, Rocky Mountain Dist. Sales Repr., Hersey Mfg. Co., 508 S. Monterey Pass Rd., Monterey Park, Calif. (Oct. '56) *M*

Afton, Village of, Richard J. Davise, Chairman, Water Board, Afton, N.Y. (Munic. Sv. Sub. Oct. '56) *MD*

Allen, Joe Thomas, Leadingman-Water Controlman, U. S. Navy, Guam, M.I. (Oct. '56) *MRPD*

Anderson, William Redmond, San. Engr., State Health Dept., Richmond, Va. (Oct. '56) *P*

Anepohl, Fred G. Jr., Effluent, Engr., American Cyanamid Co., Fortier Plant, Avondale, La. (Oct. '56) *RP*

Appel, Joe W., Sales Mgr., Water Conditioning Div., J. H. Sharf Mfg. Co., 6120 Binney St., Omaha, Neb. (Oct. '56) *P*

Bell, Philip B. Jr., Asst. Supt. of of Utilities, Box 477, Springfield, Tenn. (Oct. '56)

Botch, Philip M., Marion Building, Seattle, Wash. (Oct. '56) *MRPD*

Bowen, S. R., Mfer.'s Repr., Neenah Foundry Co., 2051 E. 46th Street, Indianapolis, Ind. (Oct '56) *D*

Branscome, Donald L., Graduate Asst., Civ. Eng. Dept. Oklahoma A. & M. College, Stillwater, Okla. (Oct. '56) *M*

Bruce, Robert G.; *see* Orchard Dale County (Calif.) Water Dist.

Call, Morris, Supt., Water Dept., Tell City, Ind. (Oct. '56) *MD*

Callfas, Wesley, Head Power Plant Operating Engr., Dept. of Water Supply, 735 Randolph, Detroit, Mich. (Oct. '56) *D*

Carman, Charles R., Sales Engr., Climax Engine & Pump Mfg. Co., 208 S. La Salle, Chicago 4, Ill. (Oct. '56) *RD*

Clark, James Henry, Tech. Serviceman, Research Center, Diamond Alkali Co., Painesville, Ohio (Oct. '56) *MP*

Colberg, Edward R., Civ. Engr., City Engrs., Office, City Hall, Rm. 401, Milwaukee, Wisc. (Oct. '56) *MRPD*

Courson, Clifford M., Plant Supt., Sewage Treatment Plant, Bureau of San. Sewers, Tampa, Fla. (Oct. '56)

Davies, Richard J.; *see* Village of Afton (N.Y.)

DeFraites, Arthur A., Cons. Engr., DeFraites Assocs., 320 E. Main St., Houma, La. (Oct. '56) *MD*

DeMarcus, John Paul, Office Engr., Eng. Dept., Bureau of Water, Knoxville Utilities Board, 626 S. Gay St., Knoxville, Tenn. (Jan. '56) *MD*

Dirasian, Henry A., Instructor, Eng. Drawing, Wayne State Univ., Detroit 2, Mich. (Oct. '56) *P*

Doherty, William J., Salesman, American Cyanamid Co., 401 N. Broad St., Philadelphia 8, Pa. (Oct. '56) *MP*

Fay, Charles William, Surveyor, Water Dept., 215 W. Broadway, Long Beach, Calif. (Oct. '56) *D*

Fourmy, James McCardell, Cons. Civ. Engr., J. M. Fourmy, Hammond, La. (Oct. '56) *PD*

Fremont, City of, Marvin Robart, 101 E. Main St., Fremont, Mich. (Corp. M. Oct. '56) *MD*

Gawthrop, Guy W., Supt., Lake Mohawk-Sparta Water Co., Sparta, N.J. (Oct. '56) *PD*

Gay, James, Supt., Water Works Dept., Monroe, N.Y. (Oct. '56) *MPD*

Gill, Allan, Mgr., Hallsdale-Powell Utility Dist., Rte. 11, Fountain City, Tenn. (Oct. '56) *M*

Gipe, Albert B., Partner, Miller, Schuerholz & Gipe, 24 E. 25th St., Baltimore 18, Md. (Oct. '56) *PD*

Glass, Donald W., Field Engr., Fischer & Porter, Hatboro, Pa. (Oct. '56)

Goldstein, Martin, Civ. Engr., 28 Kass Rd., White Plains, N.Y. (Oct. '56) *D*

Griffin, Albert Devereaux, Jr., Mgr., San. Dist., Box 36, South Laguna, Calif. (Oct. '56) *M*

Hameed, M. A., Exec. Engr., Central Design Office, Joint Water Board, New Block No. 4, Napier Barracks, Karachi, Pakistan (Oct. '56) *MRPD*

Hanger, Dave, Water Supt., Morocco, Ind. (Oct. '56) *PD*

Harnagel, Edna, Administrative Secy., Water Works, 1003 Locust St., Des Moines, Iowa (Oct. '56) *M*

Harper, Edwin B., Pres. Spring Creek Irrigation Co., 2392 E. 4800 South, Salt Lake City 17, Utah (Oct. '56) *MPD*

Holland, Paul L., Chief Engr., Anne Arundel County San. Com., 300 Baltimore–Annapolis Blvd., Glen Burnie, Md. (Oct. '56)

Holmes, William D., Asst. Mgr., Kankakee Water Co., 190 N. Schuyler Ave., Kankakee, Ill. (Oct. '56) *M*

Horton, Graydon T., Proprietor, Graydon T. Horton & Assocs., 70 Harwood Ave. S., Ajax, Ont. (Oct. '56)

Hurtado, Leon Manuel, Administrative Asst. in Eng. Office, Gee & Jenson, 428 Delannoy Ave., Cocoa, Fla. (Oct. '56) *D*

Kiel, Paul M., Resident Engr., Dept. of Water & Sewers, Box 316 Coconut Grove Station, Miami 44, Fla. (Oct. '56) *MP*

Kopisch, Arthur F., Sales Engr., National Aluminate Corp., 6216 W. 66th Place, Chicago, Ill. (Oct. '56) *P*

Kuehl, J. A.; *see* Tacoma (Wash.) Dept. of Public Utilities

Lahey, Gerald F., Supervising Engr., Northern Illinois Water Corp., 122 N. Walnut, Champaign, Ill. (Oct. '56) *M*

Levenson, Sidney, San. Engr., Corps of Engr., U.S. Army, 751 S. Figuerda, Los Angeles 17, Calif, (Oct. '56) *RPD*

Lindeman, W. G., L & K Contracting Co., Inc., 721—3rd Ave., Terre Haute, Ind. (Oct. '56) *PD*

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(*Continued from page 108 P&R*)

Martin, Robert H., Asst. Mgr., South Pittsburgh Water Co., 238 Brownsville Rd., Pittsburgh 10, Pa. (Oct. '56) *M*

McCalman, James R., Layne Northern Co., 227 W. Edwards, Indianapolis 27, Ind. (Oct. '56) *RP*

McCloud, J. L., Contractor, Southeastern Steel & Tank Maintenance Co., 1951 Maplewood Dr., Knoxville, Tenn. (Oct. '56) *M*

McCord, Kenneth A., Assoc. Engr., Whitman, Requardt and Assocs., 1304 St. Paul St., Baltimore 2, Md. (Oct. '56) *MD*

Miller, David William, Ground-Water Geologist, Leggette, Brashears & Graham, 551 5th Ave., New York 17, N.Y. (Oct. '56) *R*

Montgomery County San. Dept., Earl W. Riber, Acting County San. Engr., 127 N. Perry St., Dayton 20, Ohio (Munic. Sv. Sub. Oct. '56) *M*

Morris, C. Robert, Div. Engr., General Water Works Corp., Wilmington Suburban Water Corp.–Delaware Water Corp., 3219 Philadelphia Pike, Claymont, Del. (Oct. '56)

Nelson, Ben E., Water & Sewer Supt., La Grande, Ore. (Oct. '56)

Newman, Chester O., Assoc. Utility Engr., Hydraulic Sec., Public Utilities Com., 145 S. Spring St., Los Angeles, Calif. (Oct. '56) *M*

Nobiltt, Wilson, Supt., Water Works, Orleans, Ind. (Oct. '56)

Nussbaum, Morris, San. Chemist, Laboratory, 400 Broadway, Kingston, N.Y. (Oct. '56) *P*

O'Neil, James E. Jr., Contracting, Engr., Pittsburgh-Des Moines Steel Co., Neville Island, Pittsburgh 25, Pa. (Oct. '56) *D*

Orchard Dale County Water Dist., Robert G. Bruce, Pres. of Board of Directors, 13819 E. Telegraph Rd., Whittier, Calif. (Corp. M. Oct. '56) *MRD*

Perrey, Joseph I., Chief Engr., State Flood Control and Water Resources Com., 1330 W. Michigan St., Indianapolis 2, Ind. (Oct. '56) *R*

Perrin, Florus R., Chief Chemist, South Pittsburgh Water Co., 238 Brownsville Rd., Pittsburgh 10, Pa. (Oct. '56) *P*

Plautz, William Harold, Research Asst., Univ. of Wisconsin, Madison, Wisc. (Oct. '56) *MRPD*

Porter, Horace Leland, Assoc. in Civ. Eng., Civil Eng. Dept., Univ. of Missouri, Columbia, Mo. (Oct. '56) *RP*

Porter, Otis H.; *see* Town of Poughkeepsie (N.Y.) Water Dept.

Poughkeepsie, Town of, Water Dept., Otis H. Porter, Supt., Town Hall, Arlington, Poughkeepsie, N.Y. (Munic. Sv. Sub. Oct. '56) *MD*

Riber, Earl W.; *see* Montgomery County (Ohio) San. Dept.

Ritchey, Robert M. Jr., Asst. Engr., Frank B., Sarles, 217 Exchange Ave., Santa Rosa, Calif. (Oct. '56) *D*

Robart, Marvin; *see* City of Fremont (Mich.)

Russell, John Jewett, Treas., Kankakee Water Co., 190 N. Schuyler Ave., Kankakee, Ill. (Oct. '56) *M*

Salbini, Raymond, Water Engr., Sierra Pacific Power Co., 220 S. Virginia St., Reno, Nev. (Oct. '56) *MRPD*

Sarfaty, Raymond C., Salesman, American Cyanamid Co., 30 Rockefeller Plaza, New York 20, N.Y. (Oct. '56) *P*

Shay, John R., San. Engr., Sherman Smith & Co., 921 Summer St., Burlington, Iowa (Oct. '56) *PD*

Sherer, Lawrence Donald Jr., San. Engr., Patchen Zimmerman Engrs., 525 Telfair St., Augusta, Ga. (Oct. '56) *MRPD*

Skelton, G. G., Utility Accountant, G. G. Skelton & Assocs., 6208 College, Indianapolis, Ind. (Oct. '56)

Spade, Gordon, Chief Operator, R.D. 3, Geneva, Ohio (Oct. '56) *P*

Tacoma, City of, Dept. of Public Utilities, J. A. Kuehl, Supt., Water Div., 3628 S. 38th St., Tacoma 5, Wash. (Corp. M. Oct. '56) *M*

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Meter Boxes:
Ford Meter Box Co.
Pittsburgh Equitable Meter Div.

Meter Couplings and Yokes:
Badger Meter Mfg. Co.
Dresser Mfg. Div.
Ford Meter Box Co.
Hays Mfg. Co.
Hersey Mfg. Co.
Mueller Co.
Neptune Meter Co.
Pittsburgh Equitable Meter Div.
Worthington-Gamon Meter Co.

Meter Reading and Record Books:
Badger Meter Mfg. Co.

Meter Testers:
Badger Meter Mfg. Co.
Ford Meter Box Co.
Hersey Mfg. Co.
Neptune Meter Co.
Pittsburgh Equitable Meter Div.

Meters, Domestic:
Badger Meter Mfg. Co.
Buffalo Meter Co.
Hersey Mfg. Co.
Neptune Meter Co.
Pittsburgh Equitable Meter Div.
Well Machinery & Supply Co.
Worthington-Gamon Meter Co.

Meters, Filtration Plant, Pumping Station, Transmission Line:
Builders-Providence, Inc. (Div., B-I-F Industries)
Foster Eng. Co.
Infilco Inc.
Minneapolis-Honeywell Regulator Co.
Simplex Valve & Meter Co.

Meters, Industrial, Commercial:
Badger Meter Mfg. Co.
Buffalo Meter Co.
Builders-Providence, Inc. (Div., B-I-F Industries)
Fischer & Porter Co.
Hersey Mfg. Co.
Neptune Meter Co.
Pittsburgh Equitable Meter Div.
Simplex Valve & Meter Co.
Well Machinery & Supply Co.
Worthington-Gamon Meter Co.

Mixing Equipment:
Chain Belt Co.
General Filter Co.
Infilco Inc.
F. B. Leopold Co.

Paints:
Barrett Div.
Inertol Co., Inc.

Pipe, Asbestos-Cement:
Johns-Manville Corp.
Keasbey & Mattison Co.

Pipe, Brass:
American Brass Co.

Pipe, Cast Iron (and Fittings):
Alabama Pipe Co.
American Cast Iron Pipe Co.
Cast Iron Pipe Research Assn.
James B. Clow & Sons
Trinity Valley Iron & Steel Co.
United States Pipe & Foundry Co.
R. D. Wood Co.

Pipe, Cement Lined:
American Cast Iron Pipe Co.
Cast Iron Pipe Research Assn.
James B. Clow & Sons
United States Pipe & Foundry Co.
R. D. Wood Co.

Pipe, Concrete:
American Concrete Pressure Pipe Assn.
American Pipe & Construction Co.
Lock Joint Pipe Co.

Pipe, Copper:
American Brass Co.

Pipe, Steel:
Alco Products, Inc.
Armco Drainage & Metal Products, Inc.
Bethlehem Steel Co.

Pipe Cleaning Services:
Ace Pipe Cleaning, Inc.
National Water Main Cleaning Co.

Pipe Cleaning Tools and Equipment:
Flexible Inc.

Pipe Coatings and Linings:
American Cast Iron Pipe Co.
Barrett Div.
Cast Iron Pipe Research Assn.
Centriline Corp.
Inertol Co., Inc.
Koppers Co., Inc.
Reilly Tar & Chemical Corp.

Pipe Cutters:
James B. Clow & Sons
Ellis & Ford Mfg. Co.
Jos. G. Pollard Co., Inc.
Reed Mfg. Co.
A. P. Smith Mfg. Co.
Spring Load Mfg. Corp.

Pipe Jointing Materials; see Jointing Materials

Pipe Locators:
W. S. Darley & Co.
Jos. G. Pollard Co., Inc.

Pipe Vises:
Reed Mfg. Co.
Spring Load Mfg. Corp.

Plugs, Removable:
James B. Clow & Sons
Jos. G. Pollard Co., Inc.
A. P. Smith Mfg. Co.

Potassium Permanganate:
Carus Chemical Co.

Pressure Regulators:
Allis-Chalmers Mfg. Co.
Foster Eng. Co.
Golden-Anderson Valve Specialty Co.
Mueller Co.
Ross Valve Mfg. Co.

Pumps, Boiler Feed:
Allis-Chalmers Mfg. Co.
DeLaval Steam Turbine Co.

Pumps, Centrifugal:
Allis-Chalmers Mfg. Co.
American Well Works
DeLaval Steam Turbine Co.
C. H. Wheeler Mfg. Co.

Pumps, Chemical Feed:
Infilco Inc.
Proportioneers, Inc. (Div., B-I-F Industries)
Wallace & Tiernan Inc.

Pumps, Deep Well:
American Well Works
Layne & Bowler, Inc.

Pumps, Diaphragm:
Dorr-Oliver Inc.
W. S. Rockwell Co.
Wallace & Tiernan Inc.

Pumps, Hydrant:
W. S. Darley & Co.
Jos. G. Pollard Co., Inc.

Pumps, Hydraulic Booster:
Ross Valve Mfg. Co.

Pumps, Sewage:
Allis-Chalmers Mfg. Co.
DeLaval Steam Turbine Co.
C. H. Wheeler Mfg. Co.

Pumps, Sump:
DeLaval Steam Turbine Co.
C. H. Wheeler Mfg. Co.

Pumps, Turbine:
DeLaval Steam Turbine Co.
Layne & Bowler, Inc.

Recorders, Gas Density, CO_2, NH_3, SO_2, etc.:
Permutit Co.
Wallace & Tiernan Inc.

Recording Instruments:
Builders-Providence, Inc. (Div., B-I-F Industries)
Fischer & Porter Co.
Infilco Inc.
Minneapolis-Honeywell Regulator Co.
Simplex Valve & Meter Co.
Wallace & Tiernan Inc.

Reservoirs, Steel:
Bethlehem Steel Co.
Chicago Bridge & Iron Co.
R. D. Cole Mfg. Co.
Graver Water Conditioning Co.
Hammond Iron Works
Pittsburgh-Des Moines Steel Co.

Sand Expansion Gages; see Gages

Sleeves; see Clamps

Sleeves and Valves, Tapping:
James B. Clow & Sons
M & H Valve & Fittings Co.
Mueller Co.
Rensselaer Valve Co.
A. P. Smith Mfg. Co.

Sludge Blanket Equipment:
General Filter Co.
Graver Water Conditioning Co.
Permutit Co.

Sodium Aluminate:
Monolith Portland Midwest Co.

Sodium Chloride:
Frontier Chemical Co.

Sodium Fluoride
American Agricultural Chemical Co.

Sodium Hexametaphosphate:
Calgon, Inc.

Sodium Hypochlorite:
John Wiley Jones Co.
Wallace & Tiernan Inc.

Sodium Silicate:
Philadelphia Quartz Co.

Sodium Silicofluoride
American Agricultural Chemical Co.

Softeners:
Cochrane Corp.
Dorr-Oliver Inc.
General Filter Co.
Graver Water Conditioning Co.
Hungerford & Terry, Inc.
Infilco Inc.
Permutit Co.
Roberts Filter Mfg. Co.
Walker Process Equipment, Inc.

Softening Chemicals and Compounds:
Calgon, Inc.
Cochrane Corp .
General Filter Co.
Infilco Inc.
Morton Salt Co.
Permutit Co.
Tennessee Corp.

Standpipes, Steel:
Bethlehem Steel Co.
Chicago Bridge & Iron Co.
R. D. Cole Mfg. Co.
Graver Water Conditioning Co.
Hammond Iron Works
Pittsburgh-Des Moines Steel Co.

Steel Plate Construction:
Alco Products, Inc.
Bethlehem Steel Co.
Chicago Bridge & Iron Co.
R. D. Cole Mfg. Co.
Graver Water Conditioning Co.
Hammond Iron Works
Pittsburgh-Des Moines Steel Co.

Stops, Curb and Corporation:
Hays Mfg. Co.
Mueller Co.

Storage Tanks: see Tanks

Strainers, Suction:
James B. Clow & Sons

M. Greenberg's Sons
Johnson, Edward E., Inc.
R. D. Wood Co.

Surface Wash Equipment:
Cochrane Corp.
Permutit Co.

Swimming Pool Sterilization:
Builders-Providence, Inc. (Div., B-I-F Industries)
Fischer & Porter Co.
Omega Machine Co. (Div., B-I-F Industries)
Proportioneers, Inc. (Div., B-I-F Industries)
Wallace & Tiernan Inc.

Tanks, Steel:
Alco Products, Inc.
Bethlehem Steel Co.
Chicago Bridge & Iron Co.
R. D. Cole Mfg. Co.
Graver Water Conditioning Co.
Hammond Iron Works
Pittsburgh-Des Moines Steel Co.

Tapping-Drilling Machines:
Hays Mfg. Co.
Mueller Co.
A. P. Smith Mfg. Co.

Tapping Machines, Corp.:
Hays Mfg. Co.
Mueller Co.

Taste and Odor Removal:
Builders-Providence, Inc. (Div., B-I-F Industries)
Cochrane Corp.
General Filter Co.
Graver Water Conditioning Co.
Industrial Chemical Sales Div.
Infilco Inc.
Permutit Co.
Proportioneers, Inc. (Div., B-I-F Industries)
Wallace & Tiernan Inc.

Tenoning Tools:
Spring Load Mfg. Corp.

Turbidimetric Apparatus (For Turbidity and Sulfate Determinations):
Wallace & Tiernan Inc.

Turbines, Steam:
Allis-Chalmers Mfg. Co.
DeLaval Steam Turbine Co.

Turbines, Water:
Allis-Chalmers Mfg. Co.
DeLaval Steam Turbine Co.

Valve Boxes:
James B. Clow & Sons
Ford Meter Box Co.
M & H Valve & Fittings Co.
Mueller Co.
Rensselaer Valve Co.
A. P. Smith Mfg. Co.
Trinity Valley Iron & Steel Co.
R. D. Wood Co.

Valve-Inserting Machines:
Mueller Co.
A. P. Smith Mfg. Co.

Valves, Altitude:
Golden-Anderson Valve Specialty Co.
W. S. Rockwell Co.
Ross Valve Mfg. Co., Inc.
S. Morgan Smith Co.

Valves, Butterfly, Check, Flap, Foot, Hose, Mud and Plug:
Builders-Providence, Inc. (Div., B-I-F Industries)
Chapman Valve Mfg. Co.
James B. Clow & Sons
DeZurik Corp.
M. Greenberg's Sons
Kennedy Valve Mfg. Co.
M & H Valve & Fittings Co.
Mueller Co.
Henry Pratt Co.
Rensselaer Valve Co.
W. S. Rockwell Co.
S. Morgan Smith Co.
R. D. Wood Co.

Valves, Detector Check:
Hersey Mfg. Co.

Valves, Electrically Operated:
Builders-Providence, Inc. (Div., B-I-F Industries)
Chapman Valve Mfg. Co.
James B. Clow & Sons
Crane Co.
Darling Valve & Mfg. Co.
DeZurik Corp.
Golden-Anderson Valve Specialty Co.
Kennedy Valve Mfg. Co.
M & H Valve & Fittings Co.
Mueller Co.
Henry Pratt Co.
Rensselaer Valve Co.
W. S. Rockwell Co.
A. P. Smith Mfg. Co.
S. Morgan Smith Co.

Valves, Float:
James B. Clow & Sons
Golden-Anderson Valve Specialty Co.
Henry Pratt Co.
W. S. Rockwell Co.
Ross Valve Mfg. Co., Inc.

Valves, Gate:
Chapman Valve Mfg. Co.
James B. Clow & Sons
Crane Co.
Darling Valve & Mfg. Co.
DeZurik Corp.
Dresser Mfg. Div.
Kennedy Valve Mfg. Co.
Ludlow Valve Mfg. Co., Inc.
M & H Valve & Fittings Co.
Mueller Co.
Rensselaer Valve Co.
W. S. Rockwell Co.
A. P. Smith Mfg. Co.
R. D. Wood Co.

Valves, Hydraulically Operated:
Builders-Providence, Inc. (Div., B-I-F Industries)
Chapman Valve Mfg. Co.
James B. Clow & Sons
Crane Co.
Darling Valve & Mfg. Co.
DeZurik Corp.
Golden-Anderson Valve Specialty Co.
Kennedy Valve Mfg. Co.
F. B. Leopold Co.
M & H Valve & Fittings Co.
Mueller Co.
Henry Pratt Co.
Rensselaer Valve Co.
W. S. Rockwell Co.
A. P. Smith Mfg. Co.
S. Morgan Smith Co.
R. D. Wood Co.

Valves, Large Diameter:
Chapman Valve Mfg. Co.
James B. Clow & Sons
Crane Co.
Darling Valve & Mfg. Co.
Golden-Anderson Valve Specialty Co.
Kennedy Valve Mfg. Co.
Ludlow Valve Mfg. Co., Inc.
M & H Valve & Fittings Co.
Muller Co.
Henry Pratt Co.
Rensselaer Valve Co.
W. S. Rockwell Co.
A. P. Smith Mfg. Co.
S. Morgan Smith Co.
R. D. Wood Co.

Valves, Regulating:
DeZurik Corp.
Foster Eng. Co.
Golden-Anderson Valve Specialty Co.
Minneapolis-Honeywell Regulator Co.
Mueller Co.
Henry Pratt Co.
W. S. Rockwell Co.
Ross Valve Mfg. Co.
S. Morgan Smith Co.

Valves, Swing Check:
Chapman Valve Mfg. Co.
James B. Clow & Sons
Crane Co.
Darling Valve & Mfg. Co.
Golden-Anderson Valve Specialty Co.
M. Greenberg's Sons
M & H Valve & Fittings Co.
Mueller Co.
Rensselaer Valve Co.
W. S. Rockwell Co.
A. P. Smith Mfg. Co.
R. D. Wood Co.

Venturi Tubes:
Builders-Providence, Inc. (Div., B-I-F Industries)
Infilco Inc.
Simplex Valve & Meter Co.

Waterproofing:
Barrett Div.
Inertol Co., Inc.

Water Softening Plants: see Softeners

Water Supply Contractors:
Layne & Bowler, Inc.

Water Testing Apparatus:
Wallace & Tiernan Inc.

Water Treatment Plants:
American Well Works
Chain Belt Co.
Chicago Bridge & Iron Co.
Cochrane Corp.
Dorr-Oliver Inc.
Fischer & Porter Co.
General Filter Co.
Graver Water Conditioning Co.
Hammond Iron Works
Hungerford & Terry, Inc.
Infilco Inc.
Permutit Co.
Pittsburgh-Des Moines Steel Co.
Roberts Filter Mfg. Co.
Walker Process Equipment, Inc.
Wallace & Tiernan Inc.

Well Drilling Contractors:
Layne & Bowler, Inc.

Wrenches, Ratchet:
Dresser Mfg. Div.

Zeolite: see Ion Exchange Materials

Water Treatment, too, needs

INDIVIDUAL DIAGNOSIS

No two water treatment problems are exactly alike. The right solution to each can only be arrived at after a careful study of the local conditions. Variables such as raw water composition, rate of flow and results required automatically rule out the cure-all approach. The installation shown below is a good example of how equipment should be selected to fit the job . . . and not vice versa.

"Plantation Gardens" Florida

DORRCO ALDRICH PeriFilter* System

Meets Filtration Requirements of 1000 Home Subdivision

Consulting Engineers: Philpott, Ross & Saarinen, Ft. Lauderdale, Florida
Owner-Builder: Utilities Construction Company, Ft. Lauderdale, Florida

Plantation Gardens, an exclusive subdivision of 1000 homes having a population of 3500 persons, recently started up this compact water treatment plant for softening and color removal.

A Dorrco Aldrich PeriFilter System, consisting of a Dorrco Hydro-Treator surrounded by an annular rapid sand filter, was selected as the most economical answer to meet the conditions. The plant is designed to handle an average flow of 0.53 MGD with plans for enlargement at a future date.

Advantages of the PeriFilter system include lower construction costs because both pre-treatment unit and filter are installed in the same tank. Valves and piping are greatly simplified. Reduced head losses and simple operation add up to lower operating costs.

If you'd like more information on the PeriFilter System write for Bulletin No. 9042. No obligation, of course.

Hydro-Treator, PeriFilter T.M. Reg. U. S. Pat. Off.

Every day, nearly 8½ billion gallons of water are treated with Dorr-Oliver equipment.

DORR-OLIVER
INCORPORATED
WORLD-WIDE RESEARCH • ENGINEERING • EQUIPMENT
STAMFORD • CONNECTICUT • U. S. A.

LEADITE

Trade Mark Registered U. S. Pat. Office

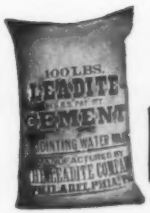
Jointed for . . . Permanence with LEADITE

Generally speaking, most Water Mains are buried beneath the Earth's surface, to be forgotten,—they are to a large extent, laid for permanency. Not only must the pipe itself be dependable and long lived,—but the joints also must be tight, flexible, and long lived,—else leaky joints are apt to cause the great expense of digging up well-paved streets, beautiful parks and estates, etc.

Thus the "jointing material" used for bell and spigot Water Mains MUST BE GOOD,—MUST BE DEPENDABLE,—and that is just why so many Engineers, Water Works Men and Contractors aim to PLAY ABSOLUTELY SAFE, by specifying and using LEADITE.

Time has proven that LEADITE not only makes a tight durable joint,—but that it improves with age.

The pioneer self-caulking material for c. i. pipe.
Tested and used for over 40 years.
Saves at least 75%



THE LEADITE COMPANY
Girard Trust Co. Bldg. Philadelphia, Pa.

No Caulking